

THE HIGHWAY MAGAZINE



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**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
Ingot) Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oregon, Portland
Coast Culvert & Flume Co.

Pennsylvania, Warren
Pennsylvania Metal Culvert Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd., Guelph, Sherbrooke, Winnipeg, Calgary.

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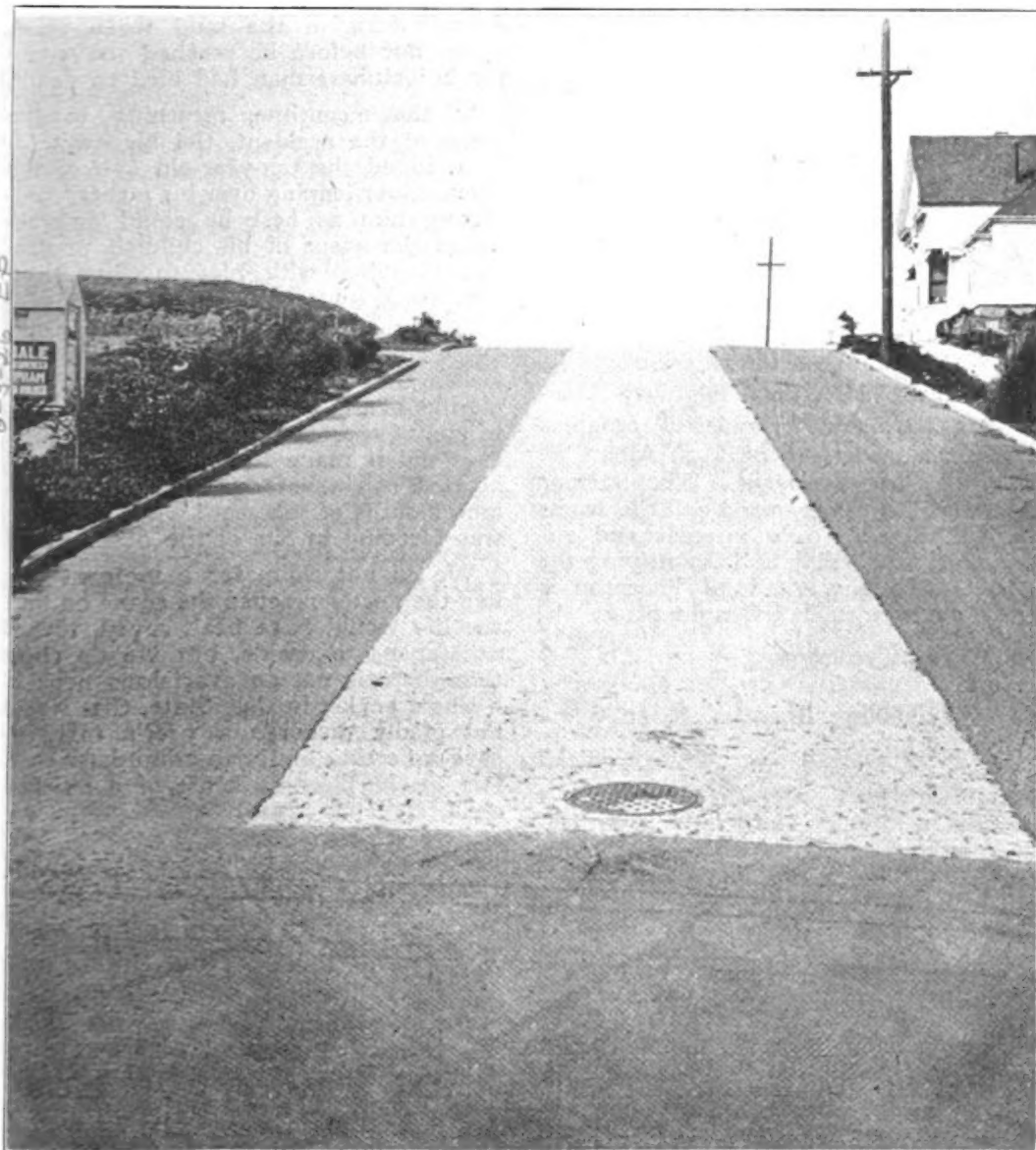
The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIII.

FEBRUARY, 1922

No. 1



By using two types of pavement on this steep grade, the City of San Francisco is kind to both horses and automobiles. The strip of basalt blocks in the center of the street makes Dobbin more comfortable on wet days, while the asphalt strips on each side provide smooth going for motor-driven vehicles.



FEBRUARY, 1922

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Women Active in Good Roads Work

THE Woman's Commission of the Bankhead National Highway Association, is making wonderful progress under the leadership of Mrs. Albert E. Thornton, its president. The various states are being organized and the women are showing deep interest and enthusiasm in marking and beautifying the Bankhead Highway. Mrs. Thornton is truly the woman in the right place.



The Nine Months' Road

A FEW years ago, a highway official of a nearby State, while campaigning for a county bond issue was frequently met with the troublesome bromide "Our roads are good enough for nine months of the year, can't you stand a little discomfort for the other three?"

It became quite a difficult question to answer as the campaign progressed, and was rapidly "getting on his nerves," when one day he came upon a heart-breaking drama that answered the question.

A truck driver, under conditions for which he was in no way responsible, undertook to cross a railroad track, and was struck by an unobserved train and

so badly injured that he died in a few hours.

As soon as the accident happened the highway official endeavored to secure a physician. He found that the local doctor was stuck in the mud three miles away. He then telegraphed to the nearest town only to be told by the physician there that the roads were so bad he would have to drive, requiring three hours to reach the injured man. A conveyance was then sent for the local doctor stuck in the mud three miles away, but before he reached the scene the unfortunate man had bled to death.

In the meantime, returning to the scene of the accident, the highway official found the ten-year-old son of the truck driver leaning over his father, comforting him as best he could and between the gasps of his childish prayers was pleading with him to "live, live, live."

It was there that the answer came. What difference did it make to that father that "our roads are good nine months of the year" when he was dying in one of the other three? What difference did it make to that little broken-hearted son that "our roads are good nine months of the year" when his heart was bleeding in one of the other three?

We do not claim for a moment that had the doctor reached the scene on time the life would have been saved, that is not for us to decide, but we do claim that there is not an avaricious nook in a single pocket in that State, that would not gladly disgorge a year's taxes to save a fleeting life or to administer comfort to the bleeding heart of a stricken child.



Maryland Completes Large Oiling Job

WHEN the Maryland State Roads Commission completed its road oiling for 1921, more than 350 miles were covered at a cost of \$88,300. This is about the same as the amount expended last year for the same purpose. The roads on the Eastern Shore were covered with the usual tar and crushed stone surface while on the Western Shore asphalt was used exclusively.

Old Lakes "Come to Life" Destroying South Dakota Roads

In 1920, the roads of Douglas County, South Dakota, were greatly damaged by heavy rains which filled up old lake beds and destroyed the highways at a number of points. Here is how Kelly Clabaugh, County Highway Superintendent, is solving the problem.



This photograph shows how the heavy rains of 1920 filled an old lake bed until it overflowed on a main highway in Douglas County, South Dakota

THE very hard rains which came so frequently during the spring of 1920 caused damage to roads and bridges in South Dakota that will take years to entirely repair or rebuild.

A number of counties in the state were forced to use nearly their entire road fund for 1920 repairing the damage done by high waters, instead of going ahead with the new work that they had planned. This, of course, has set the whole program behind and has cost some counties so much money that they will be several years catching up again.

One county which had quite a problem to meet was Douglas. A large percentage of this county, being comparatively flat, has numerous small lake-beds which were filled throughout the early part of 1920 to a height beyond all previous experiences. A good number of these lake-beds lay across the public highway; in fact, it seems as though nature put most of them there; and grades had been built through them which served very well in normal times.

However, when the abnormal high water came, several of these lake-beds

were raised over the grades and the action of the waves practically destroyed



This shows how the roads are graded to overcome high water. An ingenious method of doing this work was devised by Kelly Clabaugh, County Highway Superintendent of Douglas County.



How the overflowed lands of South Dakota are being reclaimed by drainage. Here is one of the large dredgers.

the grade entirely. To meet the immediate demand for a roadway, the commissioners got permission to open travel around the lake-beds and then set to work to repair the most important grades as fast as possible and take care of the lesser important ones when they could.

Kelly Clabaugh, county highway superintendent, has had charge of the construction work, and his ingenious methods of solving the problems encountered have done much to hurry the work along and save the county money. In places where the grade was in such bad shape that horses could not travel over it, he had straw scattered along the line of the grade for footing and then horses could get over it with small loads at first, gradually increasing them as they built up the grade.

After the grades were built up to a passable height, trouble was encountered where the waves washed out the new fill of loose dirt almost as rapidly as they could fill it in; so Mr. Clabaugh drove a row of posts along each side and strung woven wire fencing on them and filled in between the fence and side of the grade with straw and loose rock (where he could get it). This broke the force of the waves and saved the temporary grades until such time as the lake-beds

can be drained or the grade made permanent.

As these lake-beds occupy considerable valuable space which otherwise would be used for raising crops of small grain and corn, the county is rapidly planning to drain vast areas of these districts. Several of these drainage projects were started last year. The dredger shown in the accompanying photograph is a large one of the floating-dredge type. Drainage is the only salvation, and until these lake-beds are drained it will be an expensive program of continuous replacements on these grades.

• P. H. HARRINGTON

Begin Work Under New Federal Aid Act

NO sooner had the Federal Aid highway bill become a law than work was begun at once by the U. S. Bureau of Public Roads to complete the necessary preliminaries for certain important highway projects in an effort to relieve unemployment. All red tape was cut and the details are to be worked out later after the regulations for the administration of the new law will have been perfected.

San Diego County Sets Pace for Highway Improvement

Some unusually fine road construction is being carried on in San Diego County, California. The work includes the adoption and construction of a surface designed to prevent accidents at sharp curves.

IN November, 1919, the people of San Diego County, California, indicated their desire for good roads by voting the sum of \$2,300,000 for highway construction. The improvements under this bond issue are now nearing completion, and the results obtained should be of interest to other counties in various sections of the United States and Canada.

Although 133 miles of improved highway were contemplated under the bond issue, the estimates of cost were based on pavements 4 inches thick and 15 feet wide. The officials, having in mind the ever increasing automobile traffic in the

state, which has doubled in the last year, dopted the commendable policy of building wider and thicker pavements. This necessarily decreased the mileage.

A thickness of 6 inches and a width of 18 feet was decided upon for the main highways, while 11 miles of lesser-traveled sections were made 16 feet wide.

A total of 88.43 miles of roads will be improved. The average cost per mile for building will total approximately \$25,000, the paved portions alone costing an average of \$27,000 per mile.

In sections where clay or adobe were encountered, a sub-base of decomposed



This shows the specially-designed curve to prevent accidents, and the grating over the catch-basin, which insures drainage.



A view of the 12-inch Armco culvert which disposes of the water from the catch-basin mentioned in the picture at left.



A sharp curve, showing the unusual concrete construction designed by Engineer Morton for San Diego County.

granite was made, and in such sections reinforcing steel was used in the concrete. Considering as extras (over the estimates on which bond issue was based), 2 inches thicker pavement and for the most part, an additional 3 feet in width, together with special treatment of heavy sub-soil above mentioned, excellent results have been obtained for the money expended.

It is probable that two or more miles of the roads which have not been hard surfaced but have been improved under this bond issue, will be paved at a later date, and that another six miles over the new Poway grade will probably be paved from funds provided by the supervisors. As a result, when the highway commission is disbanded, it will probably have given the county 74 miles of paved and 14 miles of graded roads, the latter being surfaced with decomposed granite.

In order to prevent accidents on sharp curves, an excellent expedient has been resorted to. R. M. Morton, engineer for the San Diego County Commission, has

designed a super-elevated curve at an overhead crossing of the San Diego & Arizona Railroad. Accompanying photographs show the construction of this curve and the drainage method employed in connection with it.

As may be seen in the pictures, the right angle turn is very sharp and the specially-designed curve makes virtually two roadways with a center barrier over which a machine traveling at a high rate of speed can go without danger, if skidding should happen to occur. The roadway at this point is 24 feet wide. With a continuous slope, a deep fill would occur at the outside of the curve, whereas this special design results in a minimum fill.

As may be noted in another picture, a grating has been placed over a catch basin in the depression formed in the center of the road by the specially-designed super-elevated curve. A 12-inch Armco ingot iron corrugated culvert, which is shown in another photograph, conveys the water from this catch basin.

Mr. Morton has been previously retained in a similar capacity by San Joaquin and Sacramento counties. The personnel of the San Diego Highway Commission is as follows: Sherwood Wheaton, Chairman; Col. Ed. Fletcher, Commissioner; F. M. White, Commissioner; D. A. Frazier, Secretary; R. M. Morton, Chief Engineer; Paul Watson, Assistant Engineer; and Fred Grum, Assistant Engineer.



Plan to License Engineers in Mississippi

AT a meeting held last October in the Senate Chamber of the State Capitol, Jackson, Miss., for the purpose of organizing the local chapter of the American Association of Civil Engineers, steps were taken to draft a law licensing engineers to practice in the state, with a view of upholding the ethics of the profession. This meeting was well attended by thirty-five of the representative engineers of Mississippi.

The following officers were elected: Gus A. Draper, President; J. A. Fonville, Secretary and Treasurer, of Jackson.

The Organization of the Tennessee Highway Department

By D. Q. McCOMB, Chief Engineer

The organization of any State Highway Department must depend entirely upon conditions locally to be met and the character of work to be performed. No stereotyped form of organization, applicable equally to all states and all conditions, can be followed absolutely, but each state must work out its own form best suited to accomplish its own work efficiently and economically, and produce desired results. Mr. McComb tells briefly how the Department is organized in Tennessee.

THE accompanying "Organization Chart" shows the Tennessee Highway Department to be under the direction of a commission consisting of three members. These commissioners are appointed by an appointing board consisting of the Secretary of State, the State Treasurer and the Comptroller, one each odd-numbered year, to serve a term of six years, the commission in this way being constituted a continuing body. The officers of the commission elected among themselves, consist of a chairman, in executive charge of the entire department; a secretary, who, through the assistant secretary, in charge of the administrative bureau, attends to the details of administration, and a third member, at present commissioner of engineering (an engineer of sound judgment and extensive experience in highway construction) who is appointed as the technical member of the commission.

TWO MAIN BUREAUS

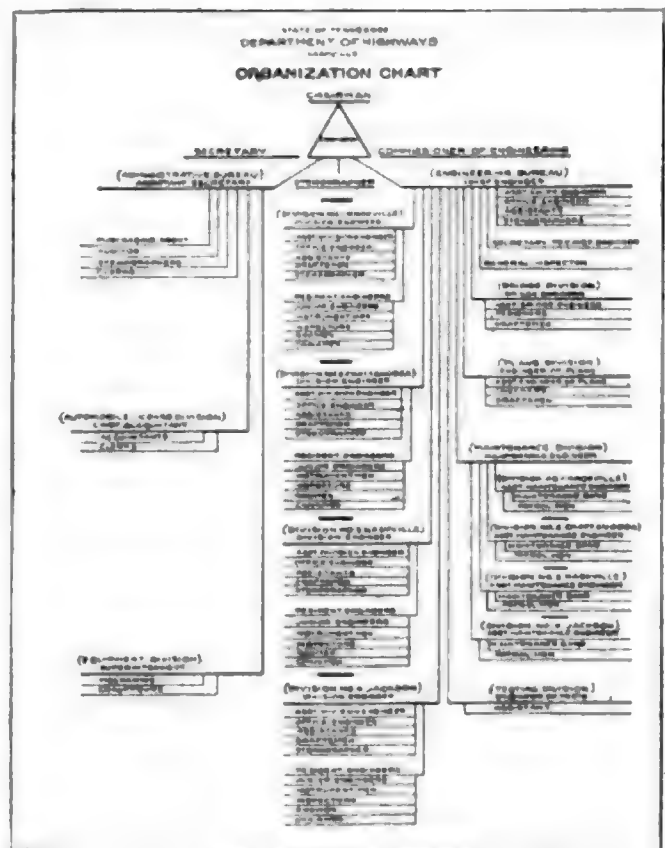
The department is divided into two bureaus; Administrative, under the direct control of the assistant secretary, to whom all heads of divisions in that bureau report direct; and the Engineering Bureau, under the direction of the chief engineer, to whom all division heads in that bureau report direct. The assistant secretary and the chief engineer report independently direct to the commission.

The Administrative Bureau is divided into three divisions—personal staff of the assistant secretary, consisting of purchasing agent, auditor, stenographers and clerks, each reporting independently of the other to the assistant secretary; Automobile License Division, in charge of the chief accountant, reporting direct to

the assistant secretary, and to whom in turn report the accountants and clerks of this division; and the Equipment Division, in charge of the superintendent, to whom the chauffeurs and mechanics report independently of each other.

THE ENGINEERING BUREAU

The Engineering Bureau is subdivided into nine divisions; (1) personal staff of the chief engineer, consisting of the secretary to the chief engineer, reporting independently to the chief engineer, and the assistant chief engineer, office engineer, assistants, and stenog-



This chart illustrates the organization of the Tennessee Highway Department, as herewith described.

raphers, each in authority in turn over those below, and each reporting through the next above, to the chief engineer; (2) Bridge Division, in charge of the bridge engineer, to whom report in turn the assistant bridge engineer, designers and draftsmen, and each in turn in authority over those below; (3) Plans Division, in charge of the engineer of plans, with assistant engineer of plans, checkers and draftsmen, each reporting through the next above to the engineer of plans; (4) Maintenance Division, in charge of the maintenance engineer, with an assistant maintenance engineer, in each of the four field divisions, reporting direct to the maintenance engineer at the central office in Nashville, and each in independent charge of maintenance in the respective divisions, with maintenance gangs and patrolmen reporting independently of each other to the respective assistant maintenance engineers; (5) Testing Division, in charge of the engineer of tests, to whom the assistant reports direct; (6) and the four field divisions, with headquarters at Knoxville, Chattanooga, Nashville and Jackson, respectively.

The division engineer is made directly responsible for preliminary work of all

classes, preparation of plans, and all construction in his division. His organization is sub-divided into two sub-divisions: Office Staff, consisting of assistant division engineer, office engineer, assistants, draftsmen and stenographer, each in authority over all below and reporting to the next above; and the field parties, in charge of a resident engineer, reporting to the division engineer, and to whom in turn report junior engineer, instrumentman, inspectors, rodman and chainman, each in turn through the next above.

The organization as outlined above, and as shown by the accompanying "Organization Chart," was very carefully worked out to meet conditions in Tennessee, and is believed to be best adapted to fulfill the requirements of this particular state.

U. S. Good Roads Association to Meet

THE tenth annual convention of the United States Good Roads Association promises to outrival in attendance and interest any good roads gathering ever assembled. Make your arrangements to go to Phoenix, Arizona, April 24 to 29, 1922.



This Armco ingot iron corrugated culvert was installed in 1911 under a state highway in Madera County, California. Paving was placed over it in 1913. The pipe is in perfect condition today.

To Keep Alabama on the Map

The Importance of Passing the \$25,000,000 Bond Issue

THE increasing diversification of crops throughout the South and the constant development of Southern industries is rapidly increasing the necessity for good roads. North Carolina has voted \$50,000,000 in State Road Bonds and is now at work building roads under that issue. Louisiana has just adopted a pretentious road-building program on the "Pay as you go" plan.

Alabama is laying the sub-structure for a greater prosperity. The people of that State realize that for Alabama to make the most of the big opportunities which are coming her way she must have good well drained roads and lots of them. Realizing this, the people of the State voted a \$25,000,000 bond issue in 1920, but it was held invalid on a technicality. The Alabama Legislature recently met and are now re-submitting this \$25,000,000 bond issue to the people to be again voted on, on January 30th, and it is a foregone conclusion that the bonds will pass by a substantial majority.

The licenses on all automobiles, trucks, and other motor driven vehicles were fixed in 1919, and a vote for or against the present bonds cannot change the price of these licenses.

A vote for the bonds will not increase taxes in any way; in fact, should reduce taxes, because the state and the federal government build and maintain the principal roads in the counties, and there will be no reason for the county boards of revenue or the commissioners to levy for this purpose.

Such counties as have already advanced money to the State for expenditures on Federal Aid Roads will have the money returned to them from the proceeds of this bond issue.

Alabama's share of the new \$75,000,000 Federal Aid appropriation is \$1,553,420. Mr. W. S. Keller, State Highway Engineer, and his associates have very fortunately been able to cinch Alabama's allotments of the old Federal Aid funds, and when these new bonds are voted, it will mean that Alabama will have funds to amply match their Federal Aid appro-



W. S. KELLER
State Highway Engineer of Alabama.

priations from year to year and build a net-work of roads over the State which will enable Alabama to better develop her great agricultural resources, her industrial life which consists of lumbering, and cotton manufacturing, iron and coal mining, and steel manufactures, and the development of water power projects, among which Muscle Shoals is a notable example.

By the passage of the new Federal Aid Act appropriating \$75,000,000 to be spent through the various State Highway Departments, the Congress of the United States has expressed its confidence in these State Highway Departments. The Alabama State Highway Department is one of the best in the country, and Mr. Keller has been nationally honored by the National Association of Highway Engineers. The people of Alabama will, on January 30th, have another opportunity of expressing their confidence in the Alabama State Highway Department by re-voting these new State bonds to be spent under its supervision. It is expected that the vote will be favorable by a large majority.

Are We Making the Most of Conventions?

Here Is What E. A. James, the Well-Known Canadian Engineer,
Says on the Question



E. A. JAMES
Consulting Engineer, Toronto and York
Road Commission.

ROAD builders are beginning to wonder whether road conventions are an excuse for a holiday or whether they are a serious part of the road program of this country.

Those in office, directing the affairs of the various road organizations, complain of the lack of interest of the delegates in the convention programs, but it seems to me that the fault lies not in the delegates, but rather with those who are directing the conventions.

Federal conventions, one would suppose, would give their time to Federal problems, and not to the gravelling of township lines. A Federal convention has numerous problems that are country-wide in their application, and when

properly introduced are of such moment as will engage the full attention of the delegates. Continued Federal aid; increased Federal aid; Federal aid for maintenance and Federal inspection of work completed, together with advanced co-operative legislation dealing with motor loads, speed of traffic and traffic regulations are live, interesting problems which will hold any Federal road convention.

Provincial road conventions have similar problems, but they are specialized in that in each province the questions are local in their application. Provincial highways and the counties' contributions; increased provincial grant to counties and suburban areas and provincial legislation, together with papers on road building peculiar to each district.

From the road builders' point of view, the third type of convention is most important; that is, the gathering together of the road builders in counties, discussing the actual building and maintaining of roads suitable to the climate, traffic and materials available in the locality.

All these types of conventions have their place, and will give an impetus to road improvement if planned for and directed as serious undertakings and not developed as an outing for luncheons, receptions, theatre parties and holidaying. Organization committees meeting before the convention can assist in directing the discussions.

Exhibitions planned so as to give the exhibitors an opportunity of intelligently explaining his products to the road builder will add interest to the convention and be profitable to both buyer and seller. These exhibitions, however, must no longer be used as a means of requiring the supply man to finance the convention.

If leaders in the Good Roads Movement cannot undertake seriously the direction of conventions, how can they expect road builders to be serious in their occupation.

Snow Removal in Michigan

How Dickinson County Solved the "White Mud" Problem

By PAUL ISRAELSON, *Engineer*, and CARL ISRAELSON, *Assistant Engineer*,
of Dickinson County, Michigan



Snow plowing on the roads of Dickinson County, Michigan. As soon as the storm "breaks" the machinery is put in operation.

SNOW removal is one of the main factors in highway maintenance in this part of the United States, and the cost of keeping the highways open for traffic during the winter months is considerable.

But the roads must be kept open, as it is absolutely necessary to insure communication both within the county and with points outside.

How Dickinson County, Michigan, has solved this problem will doubtless be of interest to road builders and maintainers in the snow belt.

It is interesting to note that during the winter of 1920, the automobile traffic on the highways of Dickinson County was held up only four days. The roads were kept open by the following method: The road commissioners purchased a 5-ton caterpillar tractor and a locomotive-type V-plow. The snow plow, which has a spread of 8 feet, is attached in front of the caterpillar. This plow makes a path for the caterpillar and our own made V-plow, which is 20 inches high, with a

spread of 15 feet. This cleared a roadway 13 feet wide.

Previously a 24-foot snow plow, drawn by eight teams, at an expense of \$80 per day for the teams and \$10 per day for the men with plow, was used. The teams would plow from 15 to 20 miles per day and the cost per mile



Where the snow is particularly heavy the caterpillar tractor breaks the way, as described in the accompanying article.



This photograph shows a road in Dickinson County, Michigan, upon which snow plowing has been done.

would average about \$3.80, the total spent for snow removal in one year being \$5,329.59. This included cost of plowing, shoveling, dragging, placing and taking down snow fences and the construction of new fences where needed. About 60 per cent of the total cost was represented by the teams.

By the present method, the teams are eliminated and with them the trouble and worry occasioned by shortage of

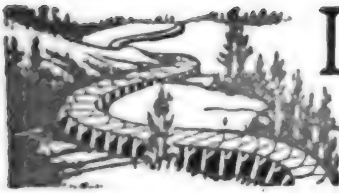
work horses and their inability to work during the storms. With the caterpillar, the driver and his helper start plowing as soon as the storm starts and continue until the storm is abated, thus preventing deep drifts from forming.

Drifts up to 4 feet and of any length can be cleared using both the V-plow in front and the 15-foot plow behind without any trouble, but in drifts of any greater depth, the 15-foot plow is unhooked and the tractor with V-plow attached, is sent through the drifts up one side and then on the other, and each time the plow is pushed a little further out, and then the tractor can take the 15-foot plow through.

We have plowed from Iron Mountain to Channing and return, about 50 miles, in ten hours, using V-plow in front and 15-foot V-plow behind. The cost to plow this distance with the tractor is about \$30. With teams and men using 15-foot V-plow, it would take four teams and two men three days to make round trip at a cost of about \$130. The average cost per mile with tractor has been about 80 cents compared to teams at \$3.80.



An excellent piece of road construction near Mt. Pleasant, Michigan. The contractors were Hileman & Hileman, of Mt. Pleasant. This firm has built many miles of fine concrete and gravel roads in the state. Note the corrugated iron culvert at the right side of the highway. A similar installation, not visible in the photograph, is at the left hand intersection.



Irrigation and Drainage



The New Irrigation Security

By PERCY A. CUPPER
State Engineer, State of Oregon

How irrigation securities can be made popular and profitable.

IT has been necessary that irrigation securities be re-established in the confidence of the people. The sudden popularity they attained some years ago was even more exceeded by their unpopularity resulting from the collapse following the exploitation period. Just why it should be so difficult to re-establish these securities is hard to understand.

Irrigation securities are not radically different from other securities, the proceeds of which are used for construction. A railroad that is not completed to the operation stage, pays no dividends. An irrigation project that fails to deliver water on the land has no funds with which to pay interest. The stockholder is a partner, the bondholder a mortgagee.

LIKE A RAILROAD

Irrigation projects have failed, so have railroads, and all other kinds of business enterprises. An irrigation system, in addition to being successfully constructed, must deliver enough water to irrigate the land, or it is a failure. Likewise a railroad in addition to being successfully constructed must deliver enough freight and passengers to produce revenues for operation and interest on the investment or go into bankruptcy.

Operation expenses of an irrigation project may mount up on account of a break, or the development of unforeseen conditions requiring heavy expenditures. Such occurrences are not peculiar to irrigation development. Witness the increased cost of railroad operation during the war and the subsequent critical transportation conditions. Notwithstanding this, we find irrigation securities dis-



PERCY A. CUPPER
State Engineer, State of Oregon.

criminated against, particularly in the eastern bond market, where they find no market at all unless camouflaged under the name of "development bonds."

Unfortunately, securities like men are known by the company they keep, and from 1905 to 1910, irrigation securities were caught in bad company. They were exploited, and fell into the class of "oil stock" and mining securities, on which a man takes a long chance and is not sup-



Irrigation has caused this once arid valley to become an agricultural paradise.

posed to complain if he loses. If irrigation could have maintained the lure of hidden gold or excited the imagination with expectations of a many barrel gusher, its securities might have held their own in this class. It developed, however, that irrigation is not a matter of exploitation—betting on big odds—but simply a business enterprise, incident to which are certain risks, which should be reduced to a minimum. Irrigation securities fell from the speculative class with a crash and a badly besmirched reputation. Several years were spent in salvaging the wreckage from exploited projects and working out a sound basis for irrigation development. The irrigation district plan, with some State assistance and supervision, appears to meet all requirements and Oregon, as well as a number of other western states have reduced irrigation development under this plan to a sound business basis. It is found, however, that when irrigation district securities attempt to break into the high society of municipal bonds, they are handicapped by the blackened reputation of their predecessors. The tenac-

ity of this bad reputation seems almost uncanny, particularly, when we stop to consider that even in the high society of municipal bonds, there is many a skeleton in the closet.

It is not my purpose to discuss the weakness of other securities, but only to point out that every issue of irrigation district bonds is entitled to careful consideration, and entitled to be accepted or rejected on its merits, and not condemned on account of failures under a system long ago discarded. A half finished irrigation project is of no value. It must be finished and water delivered. With this in mind, the underwriter purchasing an issue of bonds should be prepared to see the undertaking through to a successful conclusion, even to the extent of purchasing a small block of additional bonds, if the proceeds of the original are insufficient. Underwriters may object to this on the ground that they cannot make commitments in advance, and that engineers' estimates should be ample to cover contingencies;



Near Bishop, California, the U. S. Indian Service has installed this Armco flume to water 80 acres of rich land.



The precious water which will transform the desert into farm land, is carried by this large flume of Armco ingot iron. Many miles of this type of semi-circular conduit are used in irrigation work.

nevertheless, this view is being taken by some underwriters, who feel an obligation to the retail purchaser of their bonds to see that these bonds are made sound and good through the successful completion of the project. An irrigation project that is fundamentally sound will not become a failure because the cost exceeds the original estimate, but will be a failure if sufficient funds are not available for its completion.

The total cost of an irrigation project is not so important as the annual per acre assessment. The assessments are levied and collected each year just as state and county taxes are levied and collected. In purchasing a piece of property, we do not take into consideration the taxes that will be levied against the property for the coming forty years, but just the taxes that are now due. In considering the desirability of irrigation securities, we should pay less attention to the total bond issue, than to the annual assessment necessary to pay the principal and interest on the bonds, as the same come due, probably extending over a period of forty years. If each assessment is paid, it is obvious that the principal and interest on the bonds will be

paid. Ability to pay these annual assessments depends largely upon the returns from the irrigated lands. Each year revenues from the land should be sufficient to meet the annual assessment and leave a margin for other necessary expenses. This is the test of the feasibility of the project. This is the test of the desirability of the securities.

Not only is this true of irrigation bonds, but also of all other securities as well.

Bonds aggregating millions of dollars will be issued within the next decade for irrigation development. The rapidity with which the securities are issued and the construction work done depend upon the certainty of prompt payment of principal and interest. It behooves everyone, therefore, connected with irrigation development to maintain it on a sound business basis. If this is done, the bond buyer, the contractor, the land owner and the public will be benefited.

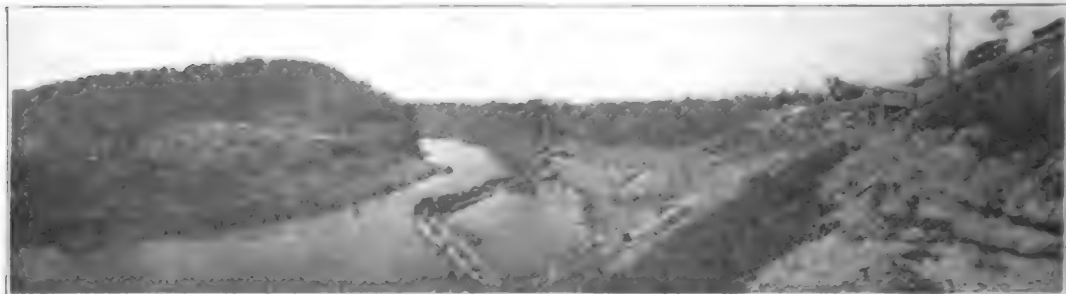


What Have You?

Have you any photos for Highway Magazine? Send them in!

Large Hydro-Electric Development Under Way in Arkansas

The first of three large dams, storing a total of 16,000,000,000 cubic feet of water, is now under construction on the Little Red River, in Arkansas.



A panorama view of the site of the dam on Little Red River now under construction by the Arkansas Hydro-Electric Development Company.

ONE of the biggest construction jobs now under way in the entire State of Arkansas, is that of the Arkansas Hydro-Electric Development Company, on Little Red River, nine miles above Searcy and Judsonia, which will produce power and light in large quantities by July 1, 1922.

The project will involve the expenditure of \$2,000,000 and the construction of a reinforced concrete dam across the Little Red River, creating a lake 18 miles long. As a part of the dam will be the powerhouse with a capacity of 22,000 horse power. The dam will be 80 feet high and 850 feet long. It will store three billion, eight hundred million cubic feet of usable water, ample to insure continuous production of electric current. The lake will cover 10,300 acres.

Upon the completion of the first dam, two others will be constructed, storing a total of 16,000,000,000 cubic feet of water. What the development of the project means can be understood from the fact that it is situated in the center of the most active district of the State, and the insistent demand from numerous cities in Arkansas for current reveals the ready market awaiting the hydro-electric power, the production of which will be cheaper than by steam plants.

The work has now passed the preliminary stages. A miniature city called

Camp Livingston has been built on the east bank of the Little Red River. Rock crushers, cableways, derricks and other machinery are now in operation. L. I. Fletcher, of the hydro-electric department of J. Livingston & Co., Inc., of New York, is personally on the ground and is superintending the work. Work on the cofferdams was completed last November.

The project is under the leadership of Dr. R. R. James of Cotton Plant, Chairman of the Board, and Virgil C. Pettie of Little Rock, Vice-President of the England National Bank, and President of the Arkansas Advancement Association, who is President of the Arkansas Hydro-Electric Development Co.

The directors are: W. N. Gregory, Augusta; F. P. Hill, Heber Springs; R. L. Block, Wynne; John E. Miller, Searcy; Alfred G. Kahn, Kramer Darragh, Hugh D. Hart, Guy A. Watkins, Secretary, W. D. Dickinson, Treasurer and E. T. Stanfield, Vice-President, Little Rock.

Now is the time, the directors believe, to push Arkansas to the front as the State to manufacture its own cotton, thereby bringing employment to a greater population, increasing land values and insuring permanent profits, which it is asserted, should be as perpetual as the water rushing through the company's dam and powerhouse.



General Hooker Used This Car in the Civil War

Yet in spite of its age and the unusual service to which it was subjected, it is still in use today. Usually railroad cars, made of ordinary steel or iron, rust out and are discarded in a comparatively short time, but there is a reason for the endurance of this historic car.

Originally it was made for the Nashville, Chattanooga and St. Louis Railroad. General Hooker made it his headquarters and General Mitchell used it as an ammunition car. General Sherman abandoned it at Kenesaw Mountain and soon afterwards the Confederate general, Hood, dumped it into the Etowah River. After the

war, it was fished out of the river, cleaned and put back in service.

A sample of the metal from this car was recently analyzed and was found to be old-fashioned iron. Chance was undoubtedly responsible for its exceptionally high degree of purity, while in ARMCO Ingot Iron, from which ARMCO Culverts are made, the purity of the metal is obtained by scientific and carefully regulated methods of manufacture.

When buying culverts for permanent installations, it is well to remember that "the purer the iron the longer it lasts."



The American Rolling Mill Company

MIDDLETOWN, OHIO



"Dig a Ditch and Roll 'em In"

—has become the popular phrase covering the installation of Armco culverts. While this simple method is not universally applicable, nevertheless there are hundreds of installations made ten or more years ago, which were "rolled in" and back filled, that are in perfect condition today. In some classes of work tunnelling is necessary; sometimes rubble or concrete head walls are added, but in practically every instance a few men with picks and shovels can install an Armco Culvert. Heavy cumbersome machinery is not required and hence the installation is easily made with a minimum interruption to traffic.

The accompanying illustration shows a rather long installation of Armco culvert. Sixteen hundred feet of it are being covered by mule-drawn bowl drags. Low cost of installation and many years' service without rust or deterioration eventually make Armco culverts the cheapest.

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MAR 14 1922

The HIGHWAY MAGAZINE



**MARCH
1922**

**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
Ingot) Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oregon, Portland
Coast Culvert & Flume Co.

Pennsylvania, Warren
Pennsylvania Metal Culvert Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd., Guelph, Sherbrooke, Winnipeg, Calgary.

The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIII.

MARCH, 1922

No. 2



PHOTO COURTESY U. S. FOREST SERVICE

ON THE "WONDERLAND TRAIL"

A picturesque scene on the "Wonderland Trail" among the giant Norway pines in the Minnesota National Forest. Many of the states are co-operating with the United States Forest Service in the preservation of the forest areas. Not only in the West, but in many of the more thickly populated parts of the United States are these beautiful regions being preserved.



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In This Issue

IN this issue of *Highway Magazine* will be found numerous important articles, either written by, or secured through interviews with, some of the leading constructionists of the United States and Canada.

W. A. McLean, Deputy Minister of Highways for Ontario, Canada, presents an unusual article entitled, "The Width of Main Highways."

G. F. S. Mann, Junior Engineer of the Tennessee State Highway Department, writes on "What Will the Highway Cost?"

E. S. Alderman, State Highway Engineer of Oklahoma, writes on "Road Maintenance and Repair."

L. E. Jones, Secretary of the Great Falls, Montana, Commercial Club, tells how "Montana Pushes the Missouri River Canyon Road."

J. R. Smith, Engineer of the Holland Land Company, California, presents an article entitled, "Replacing Small Bridges with Culverts at Low Cost."

Our Special Correspondents have contributed several important features, including a story on the huge Rim Rock Dam in Washington, based upon an interview with F. T. Crowe, Engineer of the U. S. Reclamation Service, in charge of construction; and a description

of the wonderful "Needles Highway" in the Black Hills of South Dakota.

Each issue of *Highway Magazine* contains similar articles from authoritative sources, including a wide range of subjects.

Many of the leading road constructionists will write for *Highway Magazine* during 1922.



Missouri's Share of Federal Aid

THE new Federal Highway Law reduces the appropriation to \$75,000,000 for the next two years. It is estimated that Missouri will receive about \$7,000,000 of the amount. Under the law 7 per cent of the roads can receive benefit. Figuring the total mileage in Missouri at 102,000, this will permit the use of the money on 7,140 miles. Of this mileage three-sevenths, or 3,060 miles, will receive 60 per cent, or \$4,200,000 and 40 per cent, or 4,640 miles, will receive 40 per cent, or \$2,800,000.

Add this to the bond money and Missouri will have at least \$17,000,000 with which to begin work on state roads in 1923 in addition to County and District funds amounting to several million dollars for improving and maintaining County roads.



New Jersey Allots Road Funds

AT a meeting of the New Jersey State Highway Commission it was decided to distribute the money from the motor vehicle fund for 1922 to the counties according to area, population and mileage of improved roads.



Ohio Towns to Show Name Signs

THROUGH the efforts of the Ohio State Automobile Association, the Postmaster General has issued orders that the names of towns shall be shown on signs at all rural post offices. There are about 60,000 village post offices in the country affected by this order.

The Width of Main Highways

By W. A. McLEAN

Deputy Minister of Public Highways, Ontario, Canada

How transportation is facilitated and the tax-payer rewarded by wider roads, is detailed in the subjoined article.

PORTIONS of the Provincial Highway where telephone, telegraph, power and electric railway lines are in existence or may be built, are being brought to standard widths of 86 to 90 feet where practicable. This applies only to the main lines of the system.

The majority of road allowances in Ontario were, in the original surveys, placed at 66 feet; although some, particularly in Eastern Ontario, were surveyed as narrow as 40 feet.

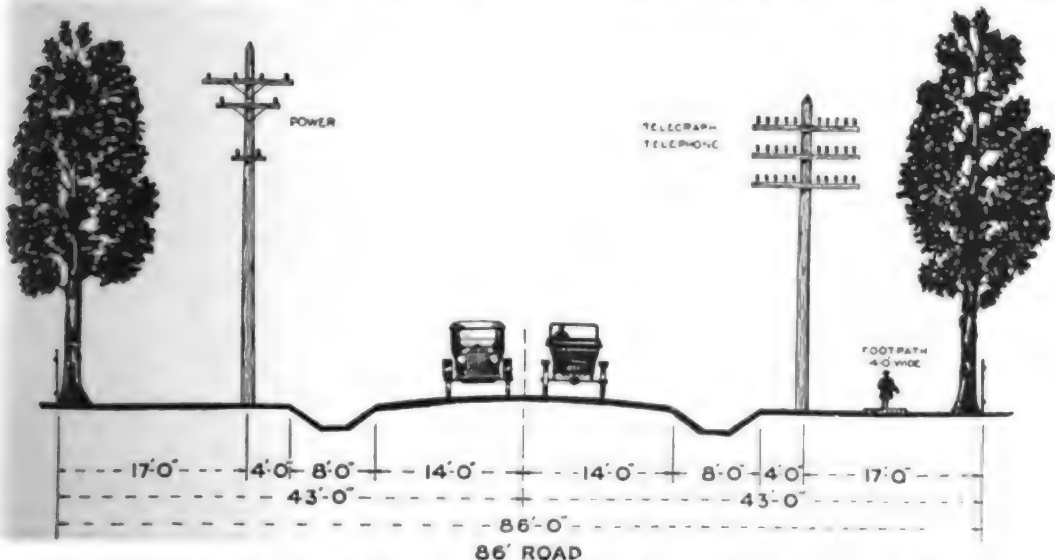
The width of highways was placed at 66 feet many years ago, and at a time when horse-drawn traffic only had to be considered. Under the original conditions, it was usually quite possible to grade and build a highway within 66 feet, and to maintain along it lines of shade trees.

Since that time, the telephone, telegraph and electric power lines, motor cars and motor trucks, have all found a place on the highway, in addition to

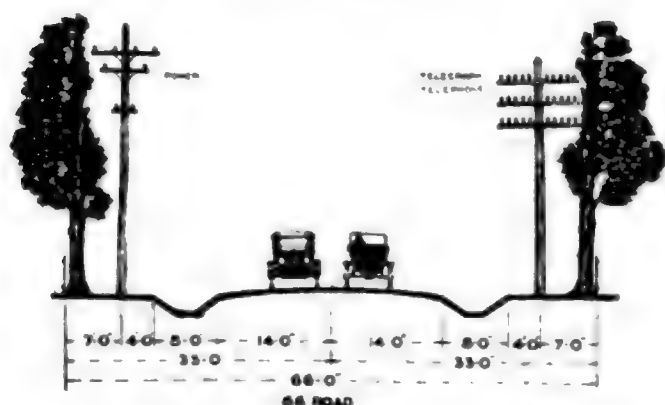
horse-drawn vehicles. We find that trees are being mutilated and destroyed on the public highways, owing to the necessity of keeping the wiring free from contact with the trees. When trees come into contact with electric power lines, very dangerous conditions arise and deaths have been caused in numerous instances.

Most of the highways are supposed to be 66 feet in width, but we find this very seldom the case. Property owners have commonly built rail fences inside the 66-foot line, and wire or other fences have been later constructed inside of the rail fences. Only 11 per cent. of the existing highway from Ottawa to Toronto is 66 feet in width, the greater part being 54 or 56 feet wide and many portions much less.

It is very generally accepted that the Provincial Highway should be of such width that lines of trees can be maintained on it, and this is impossible on the widths of highway as they now exist.



The 86-foot section retains the general dimensions for roadway shown on the next page in the 66-foot road. The width of 86 feet is obtained by adding 10 feet on each side. In this way sufficient room is secured for foot-paths, drainage, and the free development of trees, while snow troubles are greatly lessened.



On a 66-foot highway, where adequate width is reserved for road and drainage, it is evident that trees are subject to destruction to meet the needs of telegraph, telephone and power services.

In many cases, the width of 86 feet is absolutely necessary where the cuts and fills are made. Throughout the system generally, the extra width of allowance reduces the cost of grading, provides additional earth where necessary, or a convenient area for disposing of excess material within the right-of-way.

Owing to the narrowing of the highway by property owners to widths varying from 35 to 56 feet, a large amount of fence moving is necessary in any case. The 86-foot right-of-way only requires two and one-half acres additional per mile, as compared with 66 feet. This means only between one-quarter and one-third of an acre for each one-hundred-acre farm fronting on the highway. The extra cost from this source has by some been over-estimated, as the cost of land required is comparatively small. Buildings seldom have to be moved; and in all cases interference with expensive structures is avoided.

PRESENTS A STRONG CASE

The amount of traffic which grows up on a Provincial Highway makes foot-paths necessary for the safety of pedestrians; and a right-of-way only 66 feet in width is found to be too narrow for this purpose, as experienced on the Toronto-Hamilton Highway.

Weed cutting can be more conveniently carried out on a width of 86 feet, as the greater width facilitates the use of a mowing machine. Where the roadside between the ditch and the fence is narrow, and occupied by poles, it is com-

monly necessary to do the work by hand.

One of the advantages of the 86-foot width is in connection with snow roads, and the reduced cost of keeping them open in winter will be a very substantial return on the extra cost of widening. Where the road is only 66 feet in width and orchards exist along it, or where brush, shrubs, hedges, etc., grow along the fences, there is insufficient width to take care of snow drifts. On an 86-foot right-of-way this difficulty is almost entirely overcome, as drifts seldom reach the travelled portion of the road.

Having regard to the circumstances outlined, the requirements of telephone, telegraph and power lines, the desirability of maintaining trees along the Provincial Highway, the need of foot-paths, the reduced cost of grading, the better facilities for drainage, the necessary expenditures in any event for widening the highway from present narrow conditions, the convenience and reduced cost of keeping snow roads open, the comparatively small area of land required for the extra width, all combine conditions which make a very strong case in favor of the 86-foot right-of-way.

PROPERTY OWNERS PROFIT

The highway is not, as a rule, being widened through villages and towns for the reason that, as they are now built up, the cost would be too great. The difficulty is, in part, overcome in towns by using underground storm sewers in place of open ditches. This condition, as it exists in towns, indicated that the greater width should be acquired in the open country now, as the cost will every year become greater because of new buildings and other improvements along the road.

The advantage to property owners in having their land situated on a highway of this description is obvious. Land values along this class of highway invariably show decided increases, and their improvement by widening to 86 feet should have the co-operation of all property owners. The immediate inconvenience is a very temporary one, and will quickly disappear through the development of much more satisfactory conditions.

Through the "Eye" of the "Needles Highway"

A weird and beautiful road that has been opened through the Black Hills of South Dakota.



A view of Sylvan Lake, located at one end of the Needles Highway, one of the most picturesque spots in the South Dakota Black Hills.

SNUGGLED away in the heart of the granite uplifts of that most easterly spur of the Rocky Mountains known as the Black Hills of South Dakota, lies a tiny region of outdoor wonder which has been set aside by the State and National Governments to be kept inviolate from the lumberman's ax and the barbwire fence, while its one-time owners, the deer, elk and buffalo and other wild animals are again finding their homes in its spruce and aspen thickets.

This miniature kingdom of perpendicular cliffs and canyoned water-falls, with its "Call of the Wild" to those who will but listen, has been until recently almost impenetrable for the tourist but now the South Dakota State Highway Department is carrying on a plan of road development which will shortly make this territory accessible to the inexpensive but arrogant tin "Lizzie," and the outdoor lover can camp "ten thousand miles from civilization" and still be within easy reach of the telephone, telegraph and railroad transportation.

The accompanying views were taken along one of the above mentioned roads, the Needles Highway, which for its entire length of twelve miles passes



Entering "Crevasse Tunnel" on the Needles Highway in South Dakota.



The type of region through which the Needles Highway passes, showing the strange rock formation, which has given the road its unusual name.

through almost virgin forest. Its location required several months careful study and investigation by engineer Scovel Johnson of the State Highway

Department, who has successfully been carrying on its construction for more than a year with a large force of men and machinery.

Two of the photos show the "Crevasse Tunnel" which bores sixty-six feet through solid granite and is approached through a rock crevice 180 feet long, four feet wide and seventy feet deep, as left by nature, but now widened at the bottom so that cars may pass with safety. Solid rock was here removed at a cost of \$6 per cubic yard, modern compressed air machinery being used and the work completed during the most severe part of the winter. An average of 140 linear feet of drill hole was driven each ten hour shift.

Another view, taken from along the shores of Sylvan Lake, shows a well drained road, twenty-four feet wide, that invites one to explore what may be found around the next bend, while the last picture, taken from the roadside at an altitude of six thousand feet above sea level, is typical of the region itself.

South Dakota's Highway Department should be commended for its efforts in opening up this region for the public service it renders. It is indeed a natural wonderland.



Engineer Scovel Johnson, of the South Dakota State Highway Department, standing at the mouth of "Crevasse Tunnel."

Montana Pushes Missouri River Canyon Road

By L. E. JONES

Secretary, Great Falls (Mont.) Commercial Club

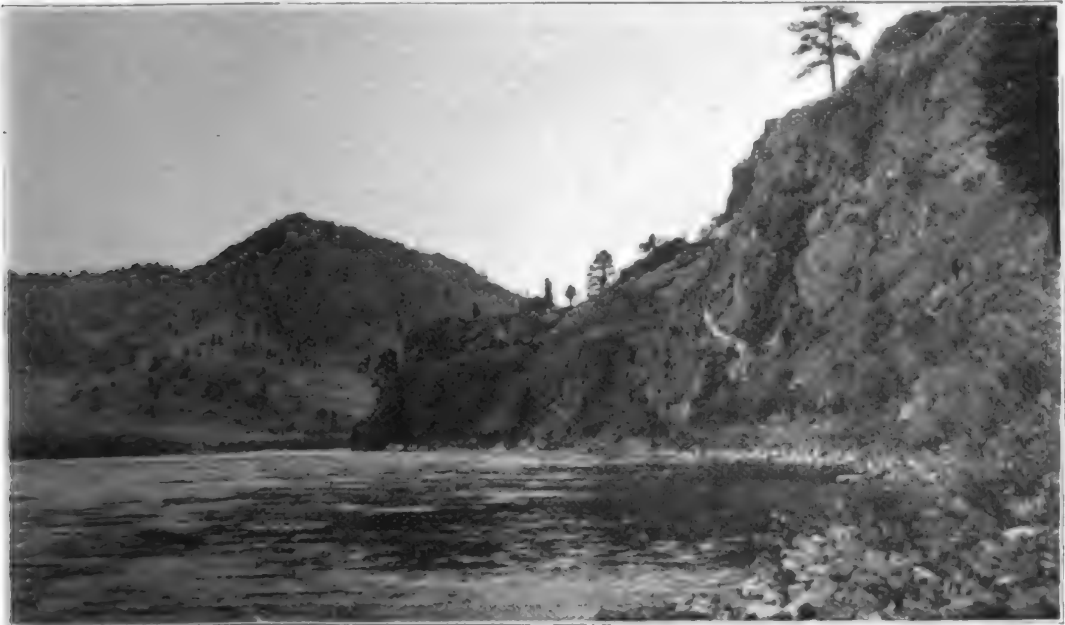
With the completion of the proposed Craig-Hardy Cut-off, the road distance between Great Falls and Helena will be lessened.

A movement to finance and construct one of the most important highway improvements in the State of Montana—The Craig-Hardy Cut-off in the Missouri River Canyon—has been initiated by the State Highway Commission, Boards of County Commissioners of Lewis & Clark County and Cascade County, Commercial Clubs of Great Falls and Helena, and various other civic organizations of the two cities.

This project begins approximately forty miles south of Great Falls, extending along the east bank of the Missouri River to the town of Craig, a distance of about fifteen miles. The object of the proposed route is to cut the highway distance between Great Falls and Helena from its present length of one hundred and twelve miles to approximately one hundred miles, and at the same time provide an all-year route. The present

location of the highway at this point crosses a divide which is snow bound about four months each year, and because of soil conditions is difficult to negotiate at many times during the remainder of the year. The proposed project is free from snow nearly the entire year and has no difficult soil conditions.

The construction features of the proposed cut-off include two highway tunnels, the longest one being 160 feet in length, and also an unusual amount of rock excavation. The estimated cost of this project from a preliminary location is \$360,000, an average of \$24,000 per mile. It is proposed to finance this project with \$180,000 of Federal post road funds, the remaining 50% to be borne equally by the two counties. In anticipation of the project, the two counties are submitting bond issues to the electors in the amount of \$100,000 each. In the event that these bond is-



Looking downstream from Station 372 on the Missouri Canyon Road, at the Craig-Hardy Cut-off, and showing alignment to point of cliff at Station 305.



Showing mountain topography on the Craig-Hardy Cut-off.

sues are approved by the voters, this road will be opened to the public before the end of the year 1922.

This route is considered the most beautiful scenic route in the state, and will undoubtedly prove of real interest to our visitors as well as ourselves.

Many Use Minnesota Roads

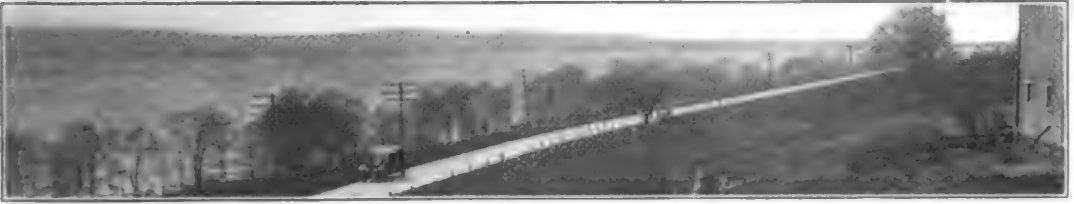
MINNESOTA trunk highways are carrying an average of 565 vehicles a day—more than 26% increase over the daily average of 435 last year, and more than three times as many as 5 years ago, Charles M. Babcock, State Highway Commissioner, announced recently.

Tennessee Publishes Highway Bulletin

THE State Highway Department of Tennessee now issues a quarterly publication called "Tennessee Highways." Its aim is to give the people of the state a clear understanding of the road-building work now in progress and planned.



The erosion which left this culvert exposed was caused by the recent flood at Pueblo, Colorado. It is a 15-inch corrugated pipe of Armco ingot iron installed near Marshall, Colorado. Note the amount of heavy earth which the culvert is supporting, without bending under the strain.



What Will the Highway Cost?

By G. F. S. MANN

Junior Engineer, Tennessee State Highway Department

The author outlines a reliable method of determining future costs and declares that this system is worth the time it takes.

ESTIMATING has been described as an art, but it may be reduced to a science. Prices of labor and material vary from time to time, as do freight rates. This makes the keeping of costs of work utterly worthless as an accurate basis for estimating the cost of new work unless an exact record is also kept of the amount of material that is required to make up a unit of the finished work, and also of the number of man-hours that are required to construct the above mentioned unit of finished work.

UNIT PRICE AND LABOR COST

The quantity of material that is required to build a unit of construction does not vary from year to year, nor does the amount of work that one man performs in a unit of time vary greatly from one year to another. Therefore, it is only necessary to multiply the required quantity of material by the current material unit price to obtain the cost of material required at any time, and similarly it is only necessary to multiply the required number of man-hours by the current labor rate to get the labor cost at any time. By labor is meant all classes of human work from the superintendent of a job down to the unskilled labor.

The cost of machinery can, and ought to be distributed to that branch of the work on which the machine is actually used. Let a steam roller be considered for an example. In one hour, at a fixed

speed, a roller will travel a certain number of lineal feet. Depending on the nature of the soil or stone that is being compacted, which determines the number of times it is necessary to pass over it, and depending on the width of the roller, it is possible to calculate the number of square yards of surface that can be compacted in one hour with a given weight of roller. This number of square yards will be very nearly constant for a given kind of soil or stone with a given weight of roller, and will not vary from time to time.

To find the cost of rolling one square yard at any time from the above data it is only necessary to find the present price of a roller of the given weight. The life of the roller may be considered as ten years (or any other figure the contractor may decide upon). Taking ten years, with twenty-five working days a month, and supposing the work is being done in a climate in which the roller may be used for twelve months in the year, then the roller has a working life of three thousand days, or at eight hours a day twenty-four thousand working hours.

THE COST OF A SQUARE YARD

To find the cost of running the roller for one hour, it is only necessary to divide the price of the roller by twenty-four thousand, and, to the result so obtained, add the price of fuel and lubricants for one hour, the man's wages for an hour, one twenty-four thousandth of the compound interest on the original



These men must know what the highway will cost! Mr. Levison, Government Engineer, and Mr. Gaddis, Division Engineer, State of Nebraska, are seen inspecting Armco culverts in Smiley Canyon, a Federal Aid Project in Sioux County, Nebraska.

investment for ten years at the current rate, and also such a sum per hour that at the end of ten years this sum with its interest will accumulate to the price of a new roller. (This last sum is charged to overhead and forms the largest part of overhead expenses.) Repairs must also be distributed to a "so much per hour" basis and added to all the above items.

If this total cost per hour is now divided by the number of square yards that can be compacted in an hour, the result will be the cost of compacting one square yard of surface.

The above method applies not only to the steam roller, but to every truck, grader, tractor, concrete mixer, etc., and even to every small tool that goes to make up the contractor's equipment.

WORTH THE WORK

There will be many contractors to whom this method will sound tedious and quite unnecessary, but it is the only certain way in which reliable estimates may be made. The compiling of the above data costs some money, but when the observations of the work done in one hour by either man or machine, and the quantities of material which are required to construct a unit of finished work, have once been accurately determined and properly recorded it is a simple matter to make accurate estimates at any future date.

Accuracy of estimating, although the primary object of such a method, is not the only reward which the contractor will

derive, for while making these time studies for the purpose of estimating, new and more efficient methods of distributing and handling men and materials will present themselves which will enable savings to be made many times greater than the sum expended in making the accurate time study and estimate.

Road to Aid Texas Oil Fields

FEDERAL and State aid to the extent of \$900,000 has been promised the counties along the line of the proposed paved highway between Houston, Texas, and Lake Charles, La., if the counties vote an additional \$300,000.

Plans are under way to call an election for issuance of bonds to take advantage of the offer. The old shell road along this route has seen hard and continuous service since Orange, Texas, has become a proven oil field.

Good Roads in North Dakota

THE North Dakota State Good Roads Association urges every county in the state to adopt a trunk road system of highways to connect with the state and federal system.

During the past 10 years the counties and townships in the state have spent \$35,000,000 on patchwork, unsatisfactory pieces of highway, with only about 3,500 miles of the 70,000 miles of highway in the state receiving any benefit from this expenditure, the association claims.

Road Maintenance and Repair

By E. S. Alderman
State Highway Engineer of Oklahoma

The author, in contributing this article, has promised to take up the maintenance of surfaced roads in a subsequent issue of Highway Magazine.

GOOD Roads cannot be had without systematic maintenance. Really economic and efficient maintenance can be secured only by means of, (1), patrols for each definite sections, and, (2), well equipped and organized gangs to perform on a number of sections all work which cannot be economically performed by a patrol or local help.

The gang system requires permanent quarters to work from and live in, to permit continuous work. Any other arrangement will result in considerable inefficiency. When not employed in maintenance, the construction of gravel and earth roads or the improvement of grades could be satisfactorily undertaken by this gang.

A PROGRAM NECESSARY

Economy commands that special equipment should not be duplicated in all gangs, but should be readily available for transfer between the gangs which may occasionally require same. Regular equipment should be sufficiently complete and satisfactory to permit economic daily operation throughout the year.

The program for the gang should be mapped out by the engineer or commissioner in charge after at least a car reconnaissance has been made of the work contemplated. Close supervision is required to secure maximum gang efficiency.

Important roads should preferably be under the patrol system. Sufficient funds should be available to supply the patrolmen with extra men and teams when necessary and to pay for materials and supplies required. The entire time of the patrolman should be devoted to the section and should have the necessary equipment, including a light motor truck or horse-drawn vehicle.



E. S. ALDERMAN,
State Highway Engineer of Oklahoma.

Earth, sand-clay, or gravel roads require that he also have 1 road grader, 1 road drag, 1 road planer, 1 large slip or scraper, 1 road plow, 1 tool box, 1 axe, bar, pick, shovel and other small tools necessary.

He is responsible for all equipment in his care. He should keep all earth and gravel roads smooth and even by use of road drag and planer; keep all culverts and ditches open; add new material to road surface where necessary; clear brush and tall weeds from roadside and especially at dangerous turns; protect side banks or fills by sowing grass seed or by sodding; construct and repair guard rails and rip rap or otherwise protect ditches,

and the toe of fills where they are inclined to wash; maintain all signs and markers, and detour signs around work under construction; make daily report; be acquainted with road and automobile laws and rules; assist stalled traffic free of charge and dispense road information gratis.

Blue grass, broom grass, Johnson grass and orchard grass are efficient in protecting new banks or fills, but sodding is the quickest method. Keeping the road surface smooth and bridges passable is the patrolman's most important duty.

Successful earth road maintenance requires that no water be allowed to stand on the surface and in the ditches, and that road surface defects be repaired immediately by the generous use of a light grader, drag and planer. Proper grading

and the existence of adequate drainage facilities are presupposed.

The ditches should be cleared and the road trued up to crown with a light grader two or three times each season. The grader can be used to remove dirt and weeds from the shoulders and material so removed should be properly disposed of where it will not interfere with the drainage. After the disposal of weeds, grading should begin at the ditch line and work toward the center of the road, the blade set at the proper angle to permit the earth freely to move towards the center of the roadway. Surplus material should be properly placed in low and washed places. Excessive crown should be avoided. A ridge of earth or sod should never be left in the center of the road, but the surplus material should be removed.

The surface and shoulders should be smooth and clear to drain easily and drainage structures and channels should be clear and operative all the time. The best time to drag is after rain or wet spell, when the earth is just dry enough to move freely, compact readily and not too easily from traffic following the drag. On light clay or loam sections, dragging may be done earlier after a rain than on heavy soil. Sandy soil should be dragged only while the surface is quite wet. The drag should not be moved faster than a reasonable walk and should not be too heavy to be drawn by a good team.

The road planer is effective in redistributing surplus earth and leaving a smooth surface, if used when the earth is damp, but not wet. A speed of 3 miles per hour is recommended for drag or road planer. The road planer should be used when the surface is too dry for the drag.

Clayey or excessively muddy sections can be improved by the addition of sand, and sandy sections may be improved by the addition of clay. The sand should be added when the road is muddy or upon a surface plowed or scarified 2 or 3 inches deep and pulverized with a disc harrow or other tool. The application of clay to a sandy surface may not require the loosening of the surface.



Working on a well-drained grade on the Needles Highway, in the Black Hills of South Dakota. The end of a 15-inch Armco culvert is seen among the rocks.



Huge Rim Rock Dam Nears Completion

Yakima Valley to be Benefitted by Big Water Supply

By E. C. BAKER

Special Correspondent, for THE HIGHWAY MAGAZINE

IN the state of Washington many thousand acres of arid sage brush land have been reclaimed by the U. S. Reclamation Service, and today what is known as the Yakima Valley is one of the most productive irrigated sections to be found in the Pacific Northwest. Lands that a few years ago could be bought for from \$5 to \$10 are today selling for as high as \$1,000 per acre.

In this section of the country there are still many thousands of acres to be reclaimed and all that is needed to make this land as productive as the rest, is capital to build storage reservoirs and canals. This is being partly taken care of at the present time by the U. S. Reclamation Service by the construction of an earth and concrete dam on the Tieton River about forty miles above the town



Bird's-eye view of the Rim Rock Dam site, at Yakima, Washington, as described in the accompanying article.

of Yakima. This dam when completed will be the highest dam of this type in the world, the building of which is under the supervision of F. T. Crowe, construction engineer of the U. S. R. S.

The dam when completed will contain about 2,000,000 cubic yards of material and be approximately 230 feet high and 900 feet on the crest and will create a reservoir capable of impounding 202,500 acre feet. Work on the dam was commenced in 1917, but owing to the war conditions, shortage of labor, the high cost of material, etc., in the spring of 1918 work was closed down on the project and was not resumed to any extent until the spring of 1921 when work on the diversion tunnel was resumed and completed in the month of October. This diversion tunnel is 2,200 feet in length and is approximately 21 feet in diameter, and will be used to divert the water of the Tieton River around the dam site during construction, and will be used as a part of the spillway system after the dam is completed.

COREWALL CONSTRUCTION

One of the unique features of the dam is a concrete core wall designed by Mr. Crowe, extending from one side of the canyon to the other. In order to find proper foundation for the corewall it was necessary in places to excavate to a depth of 110 feet, this was in the river bed, while on the east side of the river solid bed rock was found at a depth of 35 feet, and on the west side 5 feet. The corewall below the surface of the ground will be 5 feet in thickness and without reinforcement, and above the ground level it will taper to one foot in thickness at the crest of the dam, and will be heavily reinforced above the ground level.

In the construction of the corewall, Mr. Crowe is using a method known as stopeing, three main shafts are driven into the bed rock where large sump holes are constructed and pumps installed. In the bottom of these shafts, drifts 5x6 feet were driven in each direction along the line of the corewall and down into the bed rock to a depth of from 5 to 30 feet, according to the nature

of the bed rock, so that the concrete will tie into a solid formation.

After the lower drift was completed the next floor above was excavated by stopeing the material into cars in the lower drift, then run to the shaft and hoisted and dumped. This method saves a lot of labor as none of the material above the lower drift has to be shoveled into the cars. After two drifts are completed the first is filled with concrete and then the third drift is excavated and the second drift filled with concrete as before and this method is continued until the ground level is reached.

The plans for the embankment call for a hydraulic fill with a rock blanket, a 3 to 1 slope on the up stream side, 25 feet across the top of dam, and a 2 to 1 slope on the down stream side. Material for the outer slopes of the embankment will be carried by cars running from barrow pits located above and below the dam and filled by an electric caterpillar 100-ton Class 80-B Bucyrus Shovel above the dam and a 45 railroad type Bucyrus, air driven, below the dam.

They will also use eight 16-ton steam locomotives and about seventy-five 4 yard 36 inch gage dump cars. Tracks from the barrow pits will be run to the slopes of the dam over trestles at intervals in elevations of about thirty feet. The materials will be dumped from these trestles and washed by hydraulic giants to a center pool which will be divided by the corewall. A pump will be installed in the pool immediately below the corewall which will pump a large amount of the soft clayey material from the lower side of the corewall to the upper side of the corewall, leaving a fine-graded sandy material immediately against the down stream side of the corewall and a tight clayey puddle against the up stream side.

A spillway will be built on the west side of the canyon in the solid rock cliff and will have an overflow lip of 420 feet equipped with six drum gates of the Arrow-rock type, 65 feet long and 8 feet high. The spillway under normal conditions will have a capacity of 30,000 second feet and a maximum capacity of 50,000 second feet before the dam would overflow.

Replacing Small Bridges with Culverts at Low Cost

By J. R. SMITH, *Engineer* for the Holland Land Company, California

A Reclamation Project Engineer tells in the following article, why the Holland Land Company uses culverts in place of bridges on its many farm road crossings.

THE successful operation of a tract of reclaimed land, regardless of its natural resources, depends upon adequate drainage. Even the best land when allowed to become saturated with water, which often contains injurious substances, will quickly revert to its natural state or even support no vegetation but alkali weeds. And, conversely, water properly applied to land is the basis of increased production.

These facts were early recognized by the Holland Land Company when it commenced reclaiming its 25,000 acre tract of rich tule land near Sacramento, California. It was the aim of the Company to provide means for quickly removing water which had washed through

the soil during the rainy season. And it was also the Company's purpose to provide water for irrigation during the summer months. The country being quite flat and of such low elevation as to allow the water to be siphoned into the canals during late spring and summer, makes a combined irrigation and drainage system comparatively simple. By digging deep canals the problem is solved "at one fell swoop."

Many canals demand many road crossings. Bridge construction requires much loose material, equipment, tools and men. The bridge planks wear out under trucks carrying large loads of sugar beets, beans, grain, etc., to Sacramento warehouses or the levee landings. Most of the farmers prefer to haul



Installing an Armco ingot iron corrugated culvert by means of a modern tractor ditching machine, on the property of the Holland Land Company, near Sacramento, Calif. The work is described by Engineer Smith in the accompanying article.



A view taken after a section of Armco culvert pipe had been lowered into the ditch by the modern, tractor-type ditching machine. The culverts are always placed to the final grade of the ditch.

directly to Sacramento over a straight, level road, as the load is handled but once and marine insurance saved. This year the Company was kept busy repairing bridge decks as trucking showed a great increase over former years.

EASY AND INEXPENSIVE!

Where the canals are not too wide Armco iron cuverts are now being installed, instead of bridges. The culvert is hauled out to the crossing by truck, coupled up, put in place and partly back-filled within a very short time. Teams and scrapers do the rest. Culverts are always placed to the final grade of the ditch. If the ditch is to be cleaned later, it is cleaned to the culvert. The culvert can be cleaned by hand very easily. Should the Company's ditcher be working near, placing and back-filling a culvert is but an hour's work. The illustrations show how it is done with the modern, tractor-type of ditching machines. A culvert under 24 inches in diameter (not requiring riveted joints) can be placed and back-filled for three dollars by this method. That is, the labor for a culvert, equiva-

lent to a bridge 20 feet long and 16 feet wide, is furnished for three dollars!

The Holland Land Company is reported to have one of the cheapest and yet most efficient reclamations in the State of California. Short cuts such as are here illustrated help to make and sustain such a reputation.

The tract lies within the boundaries of Reclamation District No. 999, and is close to the southerly suburbs of the City of Sacramento, being connected with that city by a concrete highway. The Holland Land Company started the work in 1916, and it has been prosecuted vigorously ever since. The entire tract was under cultivation in 1917, and record crops in succeeding seasons have rewarded the farmers for their labors.

As a result of the efforts of the President, J. V. Mendenhall, and General Manager Gus Olson, assisted by an efficient organization, the Company has been able to market this land at prices which immediately attracted farmers, so that today, instead of a tule swamp, there exists here one of the garden spots of California.

ARMCO INGOT IRON



Window Frames and Other Galvanized Metal Building Products

When you build, *build for permanence*. Use Armco Ingot Iron for all galvanized parts—roofing, coping, cornices, gutters, pent houses, skylights, water tanks, ventilators, conductor pipes, window frames and sashes. Armco Ingot Iron (galvanized) has been employed extensively in various building operations which have recently been started or completed. For instance, all window frames in the Merchants National Bank Building, St. Louis, are made from Armco Iron.

Because of its purity, evenness

and freedom from imprisoned gases, Armco Ingot Iron takes and holds a purer and more lasting galvanizing coat than any other metal. So securely is the galvanizing fused with the base metal (Armco Ingot Iron) that it will not crack, scale or peel off.

Leading Engineers specify Armco Culverts for road-building, where a rugged and serviceable culvert is needed.

Look for the Blue Triangle when purchasing Armco Ingot Iron Sheets and Culverts.



American Rolling Mill Company

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ARMCO INGOT IRON Resists Rust



Portability of Armco Culverts

One of the great advantages of ARMCO Culverts is the ease with which they may be transported. The corrugated form of construction is not only strong but light, and hence road builders have found corrugated Culverts easy to transport and install under any type of road.

In pioneer work where it is difficult to transport materials until the work of grading and preparing the foundation has been accomplished the portability of ARMCO Culverts is a decided advantage.

The upper illustration shows 26 ARMCO Culverts of moderate diameter being hauled by a horse team, and in the lower illustration two 42-inch diameter ARMCO Culverts are being carried on a platform mounted on a standard motor truck.

Engineers and highway commissioners who seek in road building, low cost combined with permanence, should specify ARMCO Culverts because of the ease with which they can be transported and installed and because of their lasting qualities.

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The HIGHWAY MAGAZINE



April
1922

**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
Ingot) Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oregon, Portland
Coast Culvert & Flume Co.

Pennsylvania, Warren
Pennsylvania Metal Culvert Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
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Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
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Canada

Canada Ingot Iron Co., Ltd., Guelph, Sherbrooke, Winnipeg, Calgary.

The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIII

APRIL, 1922

No. 3



An interesting view of the Phantom Canon Highway, near Canon City, Colo., which engineers estimated would cost \$90,000 to rebuild. Volunteer labor, through the community spirit of Florence, Canon City, Victor, Cripple Creek and Penrose, rebuilt the road in two weeks, as described on page 10.



APRIL, 1922

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Easy to Read and Worth Reading

THE *Highway Magazine* for April presents to its readers several important articles either written by, or secured through interviews with, some of the leading constructionists of the United States.

White Eagle, the Sioux Indian cowboy-poet, friend of the late Buffalo Bill and contributor to several magazines, writes on the transition of the "Old West" as exemplified in the Custer Battlefield Hiway.

W. K. Allen, Civil and Drainage Engineer of Wilmington, North Carolina, is the author of an interesting article on "Protecting North Carolina Levees With Automatic Drainage Gates."

Sergeant Alvin York, the greatest hero of the World War, tells of the crying need for better roads in the Tennessee mountains, in an interview with E. J. Bruen, special correspondent for *The Highway Magazine*, and *The New York World*.

H. M. Chadwick, Chief Engineer of the Rogue River Valley Canal Co., contributes an article entitled, "Crossing a Mountain Range for Irrigation Water."

E. A. Bradbury, Secretary of the Canon City Chamber of Commerce, reports on an unusual repair job done by "volunteer labor." This article is of interest to every public-spirited road builder in the country. The frontis-

piece shows a section of the Phantom Canon Highway, which Mr. Bradbury describes.

Our Special Correspondents have contributed several important features. You will find a description of The Point Douglas Road, near St. Paul, Minnesota, which is based on an interview with J. T. Carrol, Assistant Engineer of St. Paul, in charge of construction, and also an account of the problems facing the road builder and maintenance engineer in the snow covered passes of the California Sierras.

Highway Magazine will continue in forthcoming issues to follow the policy it has in the past of securing articles on subjects of interest to the road-building fraternity from the most authoritative sources obtainable.

Several of the leading road constructionists of the country will write for *Highway Magazine* in 1922.

•••••

A Road Paved with Silver and Gold

MOTORISTS passing along the Washington State Highway between Valley and Chewelah, ten miles north of Seattle, like the charioteers of the ancient Persians, Syrians and Egyptians, are literally driving now over a silver highway, which, were it run through the mill, would net thousands of dollars worth of silver bars, according to authentic reports.

In building this highway the contractors opened a quarry of quartzite, which was crushed and spread over the road macadam surface. Investigators took samples of the bed to an assayer and learned that perfectly good silver ore, running two dollars or better to the ton, with traces of gold, had been used on the road. The job called for 7,500 tons of the ore.

•••••

Illinois Signs for 35 Miles of Road

THE State Highway Department recently awarded contracts for 35 miles of hard surfaced highways in various parts of the state.

Good Roads Force the Passing of the "Old West"

By WHITE EAGLE

Special Correspondent for THE HIGHWAY MAGAZINE

White Eagle, Sioux Indian cow-boy, poet, and author of several Indian stories, tells the readers of THE HIGHWAY MAGAZINE something of the old and the new West along the route of The Custer Battlefield Hiway.

FOR a distance of 1,500 miles, from Omaha, Neb., to Glacier National Park, Montana, runs the Custer Battlefield Hiway. It is one of the finest pieces of road engineering in the West, and traverses five states as a fitting commemoration of the historic battle and death of that famous Indian fighter, General Custer.

The writer recently traveled on horseback nearly a thousand miles over this road, from Hardin, Montana, to Omaha, Nebraska. Truly the old West has passed! The narrow trails, passable only a few months in the year, have given way to well-built roads, wide, adequately drained, straight as the surveyors' instruments can make them and carefully marked.

With the coming of the automobile, the truck and the tractor, and the building of modern roads to permit their passage without incumbrance, a new civilization has moved into the west.

It has not been so many years since



White Eagle rides down Michigan Boulevard, after a 1,000-mile horseback trip over Custer Battlefield Hiway to attend the Good Roads Congress, held at Chicago.



A section of the Custer Battlefield Hiway, over which White Eagle traveled, skirting Whitewood Hill, South Dakota, near the Wyoming State Line.

The Highway Magazine

range-stock were driven off the ranges by cattle thieves, their brands altered, and the rustlers never apprehended. But good roads have driven out the outlaw, and now stockmen turn their cattle loose to wander over the ranges of Wyoming, the Dakotas and Montana, with no other protection than the brand.

Thefts of live-stock of any consequence rarely take place now. Every rancher has his car, some of them the finest made, and it is but the matter of a few hours to get word to a sheriff, even though the ranch lies a hundred miles from a railroad.

The Custer Battlefield Hiway is today a little more than two years old, yet the records at the camping grounds at Rapid City, South Dakota—"The Gateway to the Black Hills"—shows that more than 85,000 tourists registered last year!

One of the features of this highway which follows the historic trails used by Custer's men, is the fact that it is conceded by tourists from all parts of the country to be the best marked highway west of Chicago. There is a guide post, lettered and painted in the colors of the route (red and white), on an average of every eight miles. The writer never found it necessary to inquire the way a single time on the thousand-mile trip.

The success of the Custer Battlefield Hiway from an engineering standpoint and from the point of view of the tourist is due in a great measure to the Custer Battlefield Hiway Association, of which W. H. Wallace of Sheridan, Wyo., is president.

A typical illustration of the energy and enterprise of the officials of the Association occurred last summer when W. D. Fisher, also of Sheridan, Wyo., who is

the Association's secretary, toured the entire length of the Hiway through Wyoming, South Dakota and Iowa, repainting and replacing damaged wooden signs.

Mr. Fisher and his wife donned overalls, piled their equipment into the family car, and spent nine weeks repainting more than five thousand posts, setting sixty-two new ones and resetting seventy old ones.

A circumstance that proves that residents along the Hiway as well as the tourists appreciate this well marked road was the fact reported by the secretary that he did not find one sign shot to pieces.

A few months before the writer undertook the long ride from Hardin, Montana, to Omaha, a rancher, living 40 miles from Gillette, Wyo., while at work in his hay field, was bitten by a rattle-snake. Prohibition has made the old cure of the plains no longer available, so the rancher was bundled into his high-powered touring car, and a 40-mile race with death took place over one of the finest stretches of the Custer Hiway. A record was made that would leave even Barney Oldfield jealous. The stricken rancher had sunk into a stupor from the poison during the last few minutes of the run but the doctors eventually saved him.

I once heard Buffalo Bill ask an old westerner how it was that all the old Indian and White Scouts of the prairie schooner days were such crack shots. The answer was: "Well, we just had to be." The same reason applies to why the West has developed good roads so rapidly: "We just had to have them."

Thus has isolation, the outlaw and rustler, the venom of the rattler, and the barrier of distance been overcome by the road builders of the West.



Another view of a well-banked curve on the Custer Battlefield Hiway, Davison County, South Dakota.

Draining St. Paul's "Wonder Highway"

By S. F. LASKEY

Special Correspondent for THE HIGHWAY MAGAZINE

How one mile—more than 5,000 linear feet—of corrugated iron culverts, with well-built drop manholes and substantial spillways, serve to drain the Point Douglas Road, recently constructed by Engineer J. T. Carroll of St. Paul.



A view of the Point Douglas Road, St. Paul, Minn., showing the nature of the terrain along the hillside to the right, and a swamp on the left, which involved the difficult drainage problem.

THE Point Douglas Road, built at a cost of \$228,000, and shortening the distance between St. Paul and Chicago by nearly 70 miles, stands as a notable monument of fine engineering skill.

This trunk highway, hard surfaced the entire length, is five and a half miles long. It is 24 feet wide, and the curves are widened and banked and with two-foot shoulders. Built as a permanent artery between the intersection of Hastings and Earl streets southeast to the city limits of St. Paul, this road carries a steady and tremendous burden of traffic.

A large proportion of the many hundreds of thousands of tourists passing through the Twin Cities each year traverse this highway either coming or going. Needless to say, they take away with them a very favorable impression, and a desire to return—a tribute which does credit to the builders of this road and the municipality which made the improvement possible.

The building of the Point Douglas

Road presented many features interesting to the Engineer. As it passes through a large swampy area, a difficult engineering problem had to be solved in order to provide adequate drainage. Steep bluffs on the east side of the road necessitated headwalls for all culverts, or drop manholes at each end of every culvert, with substantial spillways to prevent erosion.

Realizing that in such a road the matter of drainage is vitally important, because the correction of mistakes is costlier than on a road which is not hard surfaced, the engineers spent nearly 10 per cent of the entire cost of the road on the one item of drainage.

It is a significant fact that approximately one mile—one-fifth the length of the road—or more than 5,000 linear feet of Armco Iron Culverts were used in providing ample and permanent drainage structures.

A total of 153 individual culverts, ranging in size from 15 inches to 36 inches, were installed. Here indeed is evidence, if further evidence is needed, that pure



Installing an Armco culvert under a 24-foot fill on the Point Douglas Road.

iron has earned the confidence of engineers seeking a material with high rust-resisting qualities, combined with the strength and elasticity to give enduring service.

Purity in iron is a quality, a characteristic, which adds materially to long service under adverse conditions. In Armco ingot iron culverts, this characteristic of purity, long tested by analysis and actual service, has a direct bearing upon permanence. That this feature of permanence and serviceability is an important consideration to the engineer, is borne out by the authorized statement of the City Engineer's Office of St. Paul:

"Point Douglas Road, a permanent surfaced highway, required drainage facilities which would equal, if not outlast, the road itself. We selected Armco Ingot Iron Culverts to be used exclusively in the work because we felt that the greater durability of Armco Culverts was easily worth their price."

Point Douglas Road will long stand as a tribute to the people of St. Paul and to the engineering skill of J. T. Carroll, Assistant Engineer of St. Paul, who had charge of its construction.

• TRANSMISSION •

A Good Course to Follow

AFORERUNNER of the not long distant time when every college curriculum will contain a course in Highway Engineering is seen in the fact that a three-year course in road building

has been established by the Dunwoody Industrial Institute at Minneapolis, Minn. Classes are conducted during the fall, winter and spring and men are required to obtain practical work with contractors during the summer months.

• TRANSMISSION •

No Grade Crossings on Federal Aid Roads

GRADE crossings will be eliminated wherever possible and replaced with bridges or underpasses on all roads of the federal-aid-highway system to be constructed under federal highway act, the Bureau of Public Roads of the Department Agriculture recently announced. This policy, the announcement stated, is receiving the approval of state and railroad officials and has been endorsed by the American Association of State Highway officials.

In the three years ended with 1920, according to records available to the bureau, 3,636 lives were lost and 10,644 persons were injured at grade crossings in the United States.



A 24-inch Armco culvert under the Point Douglas Road and installed in one of the small gullies which become flooded during rains.

The Road to Sergeant York's Home

By E. J. BRUEN

Special Correspondent for THE HIGHWAY MAGAZINE and NEW YORK WORLD

Mr. Bruen recently went to interview the well-known war hero in his mountain home. Here is what the Sergeant said about good roads, and what the correspondent saw.

I HAVE completed a journey over thirty-five miles of the worst roads in the United States. It was from Livingston, Overton county, to Pall Mall, Tenn., the mountain home of Sergeant Alvin C. York, the greatest hero of the World War.

The silver lining in this particular cloud is the presence here and there of short stretches of new roadways, closed off by barricades. It is true and pleasant evidence of the march of progress and of the dawning of a new tomorrow by the linking up of this fabulously rich mountain region with the outside world.

Sergeant York is typical of the best citizenship of the range of hills which gave him birth, and which was at one time notorious for its lawlessness. Here is what he told your correspondent, in his simple direct way:

"With good roads and better schools our people will come to a better idea of civilization and what it means. At present the sort of roads we have separate us from the outside world; the building of the new roads will link us up to progress."

In the individual case of York, the completion of the roads already under construction, will mean the possibility of getting to a shipping point thousands of cedars of great value, the development of the oil wells already located on his farm and an outlet for his farm produce. At the present time he can not get anything to market except fattened stock and it takes from four to five days, when the roads are at their best, to drive cattle and hogs the thirty-five miles.

This article is about roads, however, and if your imagination will travel with me, I will lead you over some of the most impassable in the country. I might add that I found it necessary to spend three days in negotiating the trip either way. The first six miles were made in an extra-



Sergeant York has seen the wonderful roads of France and Germany. He is back home with his mother and sister, Lula, carrying on the fight for good roads in Pall Mall, Tenn.

heavy buggy to which were attached a pair of horses; eight miles were made in a conveyance peculiar to these mountains, which the natives call a hack, but which I would designate as a sort of glorified phaeton; ten miles were made by Ford car on my undertaking all the responsibility for any damages that might result to it; the remaining part of the journey was made with another Ford car, with the exception of about five miles which your correspondent was compelled to "hoof" as no conveyance could get through.

Ruts, ruts, and still more ruts were everywhere along the route. At one point, shortly after the start of the journey, the kindly driver advised me to be ready to



This is a typical view of the road leading to Sergeant York's home, which the war hero hopes to improve.

jump clear in case the buggy turned over. We usually traveled with the wheels at an angle of forty-five degrees at their base—and always in ruts. After the spring rains, the mud in many places reached as high as the hubs, but the horses, like dumb-driven cattle, toiled wearily along.

And such mud!



More like a stream than a road! Rebuilding with adequate drainage structures will be necessary before this mountain road, leading to Sergeant York's home, will be passable.

It is as red as brick dust and of about the same consistency as the candy one sees in the windows of shops where they "pull" it in the sight of the public. Whenever there appeared to be a possibility for a bad spill—for instance when the axle was removed sixty or more degrees from a flat base—your correspondent decided it were better to ruin clothes than to take a tumble. He got out! Sucking through that mud was great exercise, but the clothes worn will never again be serviceable for promenading.

The fellow who wrote so entertainingly about the poetry of motion never tried to move through that part of the Tennessee mountains over the roads which lead to the home of Sergeant York and thousands of other Americans.

Don't lose sight of the fact that here and there along the route the way was brightened by the evidence of things to come—the stretches of road before referred to, built with government aid and, to the eyes of the mountain people, heaven-sent.

Maybe you don't think that roads have a whole lot to do with temperament! The people of the mountains have become so accustomed to the bad roads that they take them as a matter of course and look upon the silent, fenced-off, white stretches of new roadway much as the traveller in the desert views the water mirage on the glistening sands. Good roads may be coming, but the people want to *use* them before they will *talk* about them. In



Culverts are an important part of good roads. Here is an Armco ingot iron culvert under a Simcoe County road, Province of Ontario, Canada.

their stoical way they refuse to enthuse. One man told your correspondent he "reckoned the government was up to some foolishness, to get votes or something." But generally the new roads were appreciated.

The only people who really object to the new roads are the lawless, and the only lawless people I met were the "wild-cat" still operators. But I was never more convinced of the intelligence and finesse of the ancient Romans, who began the spread of their civilization by building roads, than I was after my visit to the mountains of Tennessee.

When the various units of the good roads programs which have been inaugurated in Overton, Pickett and Fentress counties with government aid are completed, a marvelous country will be opened up to the motor tourist and to the sportsman.

Alvin York, the man who captured 136 Germans single handed after killing 25 others one morning before breakfast, visualized some of the possibilities:

"About the time I have succeeded in getting my school in operation," he said as he pointed down the muddy, viscid mountain trail, "the new roads will open

up our wonderland to sightseers. I can see new times coming and great prosperity."

Asked why some of his people appeared to be indifferent to the road development and its progress, the much-decorated hero said:

"The people are not indifferent but they are naturally cautious. The world outside has never taken an interest in them before, excepting around election time. With the good roads will come better understanding. Come and see us again when we have the roads built and a good hotel and everything up this way."

And his fine grey eyes flashed a vision of the future.

Autos Carry 252,000,000 Passengers in Canada

THE 420,000 automobiles in Canada covered a road mileage in 1920 which exceeded 1,680,000,000 and registered a passenger mileage of not less than 6,920,000,000. The steam and electric railroads of the Dominion combined carried but 629,121,000, according to S. L. Squire of the Canadian Good Roads Association. The number of passengers carried is 252,000,000 annually.

What "Volunteer Labor" Did in Phantom Canyon

Reported by E. A. BRADBURY

Secretary, Canon City, Colorado, Chamber of Commerce

WHEN unprecedented rains and floods wash out the roads, when State and County appropriations have been exhausted, and when Federal aid is enmeshed in a hopeless tangle of "red tape," desperate measures sometimes have to be resorted to in order to keep the lines of traffic open.

Such a condition faced the citizens of Canon City, Colorado, early in the season, and it was successfully met by the magic slogan "Volunteer Labor."

The beautiful Phantom Canyon Highway was attacked by floods. This road covers a distance of 32 miles, extending between Canyon City and Florence to Victor and Cripple Creek. It seemed a hopeless task to immediately restore this

highway for travel, and state engineers estimated that it would cost \$90,000 to rebuild the road.

Then it was that the indomitable western spirit manifested itself. The citizens of Florence started the ball rolling in an effort to reopen the scenic highway by calling for volunteer road workers. The first day 150 men, including the mayor and city hall officials as well as farmers and laborers responded. For several days work was continued with surprising speed. A request for co-operation from Canyon City, Victor, Cripple Creek and Penrose brought a whole-hearted response. Gangs of men, numbering from 75 to 150 appeared daily and at the end of two weeks the road had been rebuilt and opened to traffic.



These men saved their county \$90,000 in two weeks and re-opened Phantom Canon Highway to traffic.

Mountain Road Construction Problems

By ARTHUR BECHTOL

Special Correspondent for The HIGHWAY MAGAZINE

The author presents an unusual aspect of road-making and repairing in the mountainous regions of California, in an article which is of interest to all highway constructionists.



No detour is possible here. The traveler who will not turn back must get out and fix the road.

ROAD work in the higher mountain districts of the West is done usually once a year, early in the summer as soon as the snow permits it. The workers go forth with different tools than those of the lowland road worker, except the shovel. The problem of the "summit" road is snow, trees and rocks. The drifts must be shoveled or blasted out, and sections of such trees as have fallen across the road must be cut out and rolled aside. After a severe winter, the cross-cut saw is perhaps the most necessary tool of the mountain road crew. The gullies which have been washed in the road are leveled, and rocks thrown aside.

The difficulty of the work is largely a matter of luck. It depends upon the number of trees which have blown across the road, the depth of the snow, and the number of sheep herded on the higher land and how frequently they are moved.

Last June, I was one of a party who went to a summit of the northern Sierras

to open the road. Part of our work was at an altitude of nearly 9,000 feet above sea level. There had been an unusually heavy snow, and when we arrived at the "top" on the 15th of June, no one had succeeded in getting over. On the other side of the summit were twenty or more parties of automobile campers, who had been shoveling snow for several days. The snow was in drifts ten or twelve feet deep when we arrived.

Most of the workers were recruited. The county provided two. The proprietor of a summer resort, impatient for the tourists who had to come in over the summit, sent two. A moving picture man, there to obtain pictures of the unusual scene of clearing a road of snow in early summer, was put to work after he had taken the pictures. Stage drivers and the auto campers joined in the work.

The sheep herder is a man much



It may seem hard to believe, but this is an early summer view of a mountain road high up in the Sierras. Snow often remains until late June.



Culverts aid in keeping the mountain roads open. This Armco culvert was installed in Yosemite by park officials in 1912. It is in perfect condition after ten years of service.

abused by travelers on mountain roads. After the road has been cleared of rocks, the herder moves his flock to more favorable picking. He must do so along the highway, in order to prevent loss in the forests. And in a day's travel, a small herd of sheep will kick more rocks of surprising size down into the road than a large crew of workers can clear away in a day.

Proper drainage is everywhere needed but, on account of the lack of adequate funds, it is not possible to give it sufficient attention in the higher mountain roads. Melting snows wash deep gullies in the narrow roads. Early-season travel is made precarious. Though remote from civilization, these main trans-continental highways are traveled by thousands of automobiles each summer month, and it is here that culverts should be installed as a matter of safety. The roads are necessarily narrow. Often a plunge of several thousand feet over the precipitous mountainside would result if any speed were attempted on them, cut as they are by melting snows that sometimes threaten to remove a

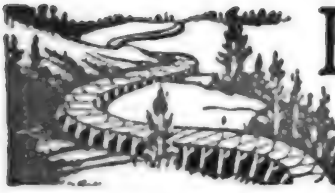
section of the road. And there is no detour. There can be only the one narrow road.

In a few sections one finds ditches along the upper side of the road and crossing it at frequent intervals. Where the mountain is high enough to retain some snow most of the summer, these ditches make travel nearly as precarious as if no work were done, for the water from the snow keeps washing these cross-ditches so that sometimes they become quite deep, and a positive danger.

In the lower, more deeply forested regions, it is frequently possible to pick a detour around some bad stretch of road. Many new roads are made this way. One picks a detour, others follow. In this way, it is a common occurrence to travel over the same general route one summer as the preceding one, and fail to recognize many parts of the road. In the less precipitous mountain districts, one sees many abandoned roads. But a detour is out of the question on the higher roads, since they are necessarily located in the mountain passes.

State or national aid is the only solution for the upkeep of these roads. Some of the most beautiful mountain districts are still almost inaccessible, because the counties in such remote districts, having small totals of taxable property in proportion to their areas and road mileages, cannot afford extensive road work. An example of this is the country in the vicinity of Lassen Peak, which is the only active volcano in the United States. Many more people would travel to this wonder if they might do so with more comfort and safety. Much of the work done on mountain roads is performed by public spirited residents.

Auto travel over these highways is increasing every year. With the increase comes the demand for more work and better drainage of high mountain roads. Western newspapers have urged it, and there has been a demand for making these roads suitable for trans-continental military highways, as a national necessity. At any rate, these demands will aid in getting better and safer roads over the summits which must be crossed on a central coast-to-coast trip.



Irrigation and Drainage



Crossing a Mountain Range for Irrigation Water

By H. M. CHADWICK

Chief Engineer, Rogue River Valley Canal Co.

The author relates of an engineering feat in which water was conveyed from the east side to the west side of the Cascade Mountains through an 11-mile open channel without tunnels.

CLIMATE, land and water have been united in the Rogue River country of Oregon with a result that produces some of the finest fruit in the United States.

Nature furnished the climate and soil several thousand years ago, but the finest pears in the country were not produced until man added the third very necessary element—water.

In solving the problem of irrigating 30,000 acres of land, the Rogue River Valley Canal Company performed a very unique engineering feat in conveying water from the east side of the Cascade Mountains to the west side of the range, all in open channel and without the aid of tunnels.

From Four Mile Lake Reservoir on the east, to Fish Lake Reservoir on the west, the water is conducted a distance of 11



This sturdy flume of Armco ingot iron is installed on Rogue River Valley Canal Company's project at Medford, Ore. It is one of the 37 flumes found necessary to properly irrigate 10,000 acres of rich agricultural land, as described in the accompanying article.



Another view of Armco flume on the Medford project. Chief Engineer H. M. Chadwick in foreground.

miles in a channel with a carrying capacity of 90 second feet.

In the construction of the Medford Irrigation Project, which includes 10,000 acres of the total Rogue River Valley Canal Company's project, 37 flumes were found necessary. These flumes are made from galvanized Armco ingot iron. They are of various sizes, ranging from the No. 84, with a diameter of 4.46 feet, to the No. 180 with a diameter of 9.55 feet, and with capacities of from 12 second feet to 175 second feet.

Five of the flumes on the Main Canal from Little Butte Creek are branch flumes, and are on curve alignment owing to the precipitous nature of the country.

One of these flumes is on a 115-degree curve. The substructure of this particular flume was erected with unusual care, and the curve sheets made a perfect fit. It has given absolute satisfaction since it has been in operation.

From Fish Lake Reservoir, on the West side of the mountains, the water is allowed to flow down the channel of the North Fork of Little Butte Creek for about 14 miles. It is then diverted into the Little Butte Canal, which is 16 miles long, and upon which there are 11 Armco flumes. From the end of this canal, two others are taken, a High Line 50 miles

long and a Low Line 27 miles long, the former involving two siphons and 15 flumes and the latter, 10 flumes.

Warped concrete transitions have been built on all flumes and this construction will be carried out on all future flumes. The value of "n" used for the metal flumes was .0115 and .012, varying according to curvature and length of flume, and the distance from center to center of bents is 15 feet on straight flumes, and less on curved flumes. Concrete pedestals were built under all the posts.

Water has transformed the Rogue River Valley into a high-class, fruit-raising center. Land has increased enormously in value. The average holding is about twenty acres. Alfalfa as well as all kinds of fruit and berries are grown successfully, but the district is becoming chiefly famous for its fine quality pears.

The accompanying photographs were taken by the writer and by H. D. Powell, Engineer for the Medford Irrigation District.



An Armco flume carrying water over a gully on the Medford project, Rogue River Valley Canal Company.

Protecting North Carolina Levees with Automatic Drainage Gates

By W. K. ALLEN

Civil and Drainage Engineer, Wilmington, North Carolina

A survey of some of the problems and their solution, in maintaining the levees on the Cape Fear River in isolated sections of Bladen County, North Carolina.

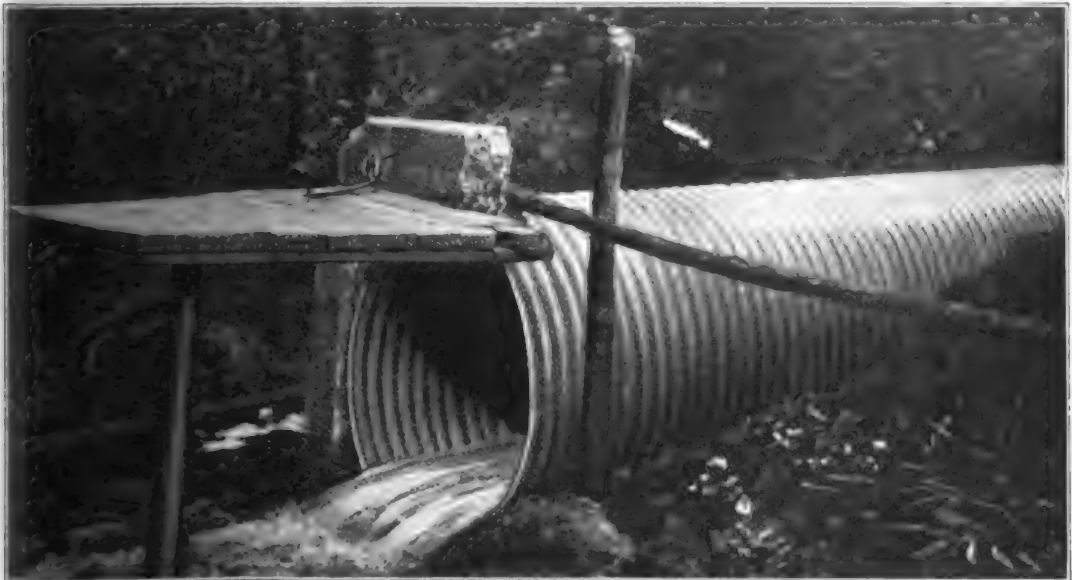
A LONG the Cape Fear River, some fifty odd miles from Wilmington, North Carolina, in the remote reaches of Bladen County, runs the Lyon Swamp Levee. The topography of the land and the nature of the surrounding terrain have united to confront man with a flood menace and a consequent drainage problem, ever since the white man invaded the country.

One of the most difficult aspects of the situation to contend with, was the sparsely settled condition of a great deal of the region adjacent to the Lyon Swamp Levee.

Equipment designed to carry off the flood waters and prevent inundation of low-lying regions would become faulty and fail to function, with the result that great damage would occur before the rising waters could be checked. A sluice gate or a dam might go out, and it



A view of one of the home-made flood gates in Bladen County, showing the poor construction of the wooden gate. Note cracks in concrete headwall and ill-fitting trap.



No. 2. Here the concrete has been nearly torn away and the gate is supported by poles and propped open. The Armco culvert, which has been in place 12 years, is in excellent condition. A Calco Automatic Drainage gate, shown on the next page, has now replaced the make-shift water-control device.



No. 3. Calco Automatic Drainage Gate installed in place of old style wooden gate.

would be days before a man could get into the river's *Hinterland* to ascertain the trouble. Many times, conditions had by then become so bad that only by a great outlay of money and time could disaster be averted.

Flood gates were installed, but they were generally crude affairs that were independable, in that they were only partially automatic.

They would open perfectly, but generally failed to close, and had to be inspected and closed by hand, thereby requiring the services of a watchman, and when closed afforded poor service because of the warped condition of the wooden gate which did not fit the concrete wall perfectly and allowed the backwash to pass through around the edges.

Illustration No. 1 shows one of these structures. It will be noted that one concrete wing wall has been washed away, also that the back wall is badly cracked. The gate was made of wood, and while it would open to allow the outflow of water, it would never close properly to prevent the backwash.

Eventually, nearly all the concrete work had been torn away, as can be seen in photograph No. 2. The gate had to be held in place by being wired to a pole, and it was necessary to close the

gate by hand, after it had been propped open, as pictured in the cut.

The drainage pipe used on this project was a 70-foot Armco culvert, 48 inches in diameter, installed in 1910, under a 16-foot fill. In inspecting it to ascertain whether the installation of new pipe was necessary before building new concrete walls and installing a new gate, it was found that the pipe was in perfect condition and was evidently good for many more years' service.

It was decided to install a Calco Automatic Drainage gate in place of the old wooden gate. This cast iron, automatic drainage gate, shown in illustration No. 3, has been widely adopted in recent years and is solving the problems of irrigation and drainage engineers.

When installing the automatic gate at the outlet end of the culvert, the remainder of the concrete work was torn away and two feet of the old pipe was cut off. The new pipe, with the Calco gate attached, was riveted on, and the joint incased with a reinforced concrete collar, eight inches thick and four feet long, with a substantial foundation.

This particular gate, pictured in photograph No. 3, has been installed almost two years and it has given perfect satisfaction.

The gate is so hung and counter-balanced, having double hinges and great flexibility of bearings, as to be extremely sensitive to water pressure from either direction. A small stream of water coming through the intake will swing the gate open and allow for drainage. But when the water at the outlet end rises, pressure becomes greater on the opposite side of the gate and the device is neatly closed.

Delicacy and certainty of operation make this type of gate peculiarly adaptable to the isolated regions of the Cape Fear River Levees. It is dependable and needs no attention.

A good idea of the ease with which one of these Calco gates may be installed under adverse conditions, can be gained from the fact that at no time during the installation was there less than seven inches of water running through the pipe.

ARMCO TRADE MARK INGOT IRON

FOR GAS AND ELECTRIC WELDING



When Iron Runs Like Melted Butter

A gaping crack or a break in the iron! Five to six thousand degrees of heat blazed into the crack until the iron melts! Then the welding metal flows into the open space, makes a perfect union with the broken iron, and the break is healed.

Welding is not like sticking together two pieces of wood with glue. In welding, the iron that is used to fill the crack must become an inseparable part of the iron that is broken (or of the two parts that are to be joined).

"Armco" Ingot Iron makes a perfect union. Impurities that might prevent this have been removed from "Armco" Ingot Iron, permitting the tiny molecules to hug one another closely.

The same basic purity which makes "Armco" Ingot Iron perfect for welding, insures resistance to rust.

Culverts made of "Armco" Ingot Iron are guaranteed 99.84 per cent pure, and will resist corrosion under the most adverse conditions.

Thousands of "Armco" culverts, corrugated to add strength, and covered with a two ounce coating of galvanizing per square foot of metal to give even greater resistance to corrosion, are in perfect condition today after a decade of service.

Write for Needed Information

The American Rolling Mill Company
MIDDLETOWN, OHIO



EASE OF INSTALLATION

IN THE large amount of data which we have accumulated concerning the use of ARMCO Culverts, two vital points predominate—ease of installation and permanence. Ease of installation includes not only the actual work of installing the culvert under highways and railroads, but also the ease with which they can be loaded and shipped on cars, and conveyed on trucks, wagons, mule packs or by workmen, to the locations at which they are to be installed.

UNDER ALL CONDITIONS

Local conditions affect many installations to such an extent that the installation of other forms of culverts are often impracticable, if not impossible. Hence economy of transportation and ease of installation favor the selection of ARMCO Culverts.



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The HIGHWAY MAGAZINE

MAY
1922



**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
Ingot) Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oregon, Portland
Coast Culvert & Flume Co.

Pennsylvania, Warren
Pennsylvania Metal Culvert Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

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Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd., Guelph, Sherbrooke, Winnipeg, Calgary.

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VOL. XIII

MAY, 1922

No. 4



Photo Courtesy E. S. Shipp, U. S. Forest Service.

ON THE NATION'S "RIDGE-POLE"

At the ridge-pole of the Continent. The dividing line of the Atlantic and Pacific watershed. This is also the boundary line between Beaverhead County, in Beaverhead National Forest, and Ravalli County, in Bitterroot National Forest, Montana. Elevation, 7,000 feet above sea level.



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Lincoln Highway on the Cover

THE cover design for *Highway Magazine* this month is a scene along the Lincoln Highway, possibly the most travelled trans-continental motor road in America. Thousands of tourists from the East and West traverse this highway every year. It has opened up the scenic wonders of the West to the pleasure seeker and has saved millions of dollars in increased transportation facilities for the motor truck.

Muscle Shoals to Have Paved Highway

A DIRECT outlet from the Bee Line Highway to the Muscle Shoals project at Sheffield Ala., is provided in the improvement of the road which leads past Wilson Dam from Florence to Rogersville and thence to Decatur on the Bee Line, authorized by the Alabama State Highway Commission at a recent meeting.

Work on the project will begin as soon as government approval is given and the contract can be advertised. The state of Alabama and Lauderdale County will each advance 25 per cent of the cost to meet the 50 per cent advanced by the government under the Federal Aid Act.

This highway, it is stated, will afford a direct outlet from the Muscle Shoals project to a trunk line north and south highway.

Need Highways for Defense

Quoted from a Statement by Major W. T. Carpenter, Coast Artillery Corps, U. S. A.

THE nationalizing of our highways, our motor vehicle laws and the co-ordination of all constructional development interests, and the benefits to be derived therefrom, including those of defense, is a vital problem which we know will eventually be solved. In this the present generation has a most serious part to play from the standpoint of present and future economy.

We must first plan the route for our highways with every thought for the future, and in doing so the advantages of railway, waterway and aerial transport must be considered and assigned their natural position in the great transport field. The details of construction must receive immediate consideration from the standpoint of life-economy. We must profit by recent mistakes in this respect and build our highways and bridges with a view to strength and durability.

Colorado Building Mountainside Road

ONE of the most difficult pieces of road building the State of Colorado has undertaken is that known as Federal Aid Project No. 78, which is locally designated as the Battle Mountain road. The road is located 30 miles north of Leadville and 18 miles north of the famed Tennessee Pass, following the Eagle Canyon and forming the gateway to the western slope of Colorado. This project begins at the mining town of Gilman, 9,000 feet above sea level, where the Empire Zinc Company has extensive holdings.

The problem of building this road gave rise to many engineering difficulties, the greatest of which was that of descending 200 feet within the allowable grade and limit of curvature, under which the federal aid could be obtained. The estimated cost was \$40,000 per mile, one-half of which is paid by the federal government. It may be mentioned that the \$20,000 per mile on this road is the maximum share paid by the government for any graded road.

Gravel Road Maintenance and Repair

By E. S. ALDERMAN

State Highway Engineer of Oklahoma.

Here are a few valuable suggestions, based upon actual experience, which will be of interest to builders and maintainers of gravel highways.

PROPER gravel road maintenance requires constant attention, the repairs beginning when the road is opened to traffic and the method depending upon the character of the gravel used which may be either (1) clay gravel, (2) decomposed chert or (3) river gravel.

The patrol system, using an extra gang when necessary, is the most economical and efficient method of maintaining gravel roads, no patrolman having more than ten miles.

Gravel roads are never hard enough and smooth enough when opened to travel to prevent almost immediate rutting. The greatest amount of maintenance will be required directly after opening the road to travel, before the gravel has become thoroughly compacted by maintenance and traffic.

If there is too much clay in the gravel, the surface will cut up in wet weather

and be muddy. A thin layer of sandy gravel should be applied to the wet or moist surface and allowed to mix under travel. Holes should be filled with more wet or moist clay gravel. The surface should be kept smooth by dragging after every rain for the first year. After the surface has become compacted, it will be necessary to drag only after rains of long duration. Dragging will be especially effective in late fall and early spring when the frost is coming out and before the gravel is fully settled.

If there is too little clay in the gravel, the surface will ravel in dry weather. A layer of clay should be added and harrowed into the gravel. Usually from 10 to 20 per cent clay makes a satisfactory binder.

Scrapers are effective on a dry road especially where the gravel is displaced through lack of sufficient binder, but a



A fine example of a well-maintained graveled road, after a bituminous surface treatment has been applied to preserve the gravel. A bituminous carpet coat will last from six months to two years, with moderate repair, according to the author.

The Highway Magazine

drag should always be used when the road is wet. At first, scraping may be necessary between rains, but after the surface is fairly compact, a drag with a steel cutting edge will be all that is necessary.

Holes should be cleaned of mud, the surrounding surface loosened up and moistened, the depression filled with moist new material, and compacted down even with the rest of the surface.

When the surface becomes so badly worn that patching and dragging are ineffective, the road must be entirely resurfaced. The surface should be cleaned of vegetable matter and refuse. The old gravel should be scarified, harrowed, reshaped, thoroughly moistened and rolled. Large stones uncovered by the scarifier and harrow should be removed. Moist new gravel uniformly graded from three-fourths of an inch down with the proper amount of binder should then be uniformly applied about two inches thick or more if desired, shaped and rolled. The surface should be kept smooth with scraper or drag until well compacted.

A gravel road will last longer if rolled every spring and after the first rains in the fall, the rolling being done when the road is fairly soft, but not while water is standing on it.

For heavy traffic, it may be advantageous to apply a bituminous surface treatment to preserve the gravel. The treatment should be with a road binder consisting of either heavy asphaltic oils, malthos, asphalts or tars, applied hot or cold as the material may require. A pressure distributor is recommended in order to secure uniformity of application. The bituminous carpet coat formed by hot application of an asphaltic binder seems to be most satisfactory. One-third to three-fourths gallon per square yard is required for the first application which is allowed to stand and soak into the road. This

coat is then covered with stone chips or clean sand to prevent loss of bitumen by traffic, to reduce slipperiness and increase the wearing qualities of the surface.

A bituminous carpet coat will last from six months to two years with moderate repairs. Horse-drawn and steel-tired vehicles will tend to destroy the coating while rubber tires will effect it very little.

Cost of Highways in Quebec

ACCORDING to S. L. Squires, chairman of the executive committee of the Canadian Good Roads Association, the cost of the work done on highways prior to 1912 aggregated \$40,000,000, while the amount spent by the province since that date amounted to \$30,000,000. This constitutes a total investment in Quebec highways of \$70,000,000. The number of automobiles entering Quebec in 1920 totaled 34,435.

\$5,000,000 for West Virginia Roads

OF the \$15,000,000 bond sale authorized by the last legislature, \$4,000,000 has been made available for work during 1922, \$6,500,000 for 1923 and \$4,500,000 during 1924. The Federal aid for 1922 is \$852,000 so that something over \$4,800,000 will be available for construction this year. In November and December contracts were awarded amounting to \$2,860,736 including \$65,568 for bridges.

The road work is as follows:—gravel, 2 miles; water bound macadam, 6.6 miles; bituminous, 47.2 miles; concrete, 29.7 miles; grading only, 56.8 miles; total, 142.3 miles. These represent 39 projects in 30 counties. Other contracts will be let as fast as surveys and estimates can be made.



After construction comes maintenance. A well-maintained graveled road will increase land values more than a poorly-maintained hard-surfaced road.

Running a Circus to Raise Road Funds

By K. H. LANSING

Special Correspondent for The HIGHWAY MAGAZINE

How a progressive Pennsylvania automobile organization "put across" a big tent show and collected thousands of dollars for improving a road after township, county and commonwealth had balked.



Part of the 1,000 automobiles parked outside the circus grounds at the Saturday matinee performance of the circus, that pulled the Providence road out of the mud. This road is no longer known as the "Swiss Cheese" road.

THINK of an automobile club so eager to promote good roads that it bought outright an entire circus and then staged it to raise funds for highway improvement. Yet that is precisely what the Keystone Automobile Club of Philadelphia did, and it is safe to say that it is a pioneer in this line.

The circus—"big top," side shows, callopie, ballyhoos, funny clowns, plenty of wild animals and everything—was a marked success and the club "cleaned up," over and above the purchase price, the neat sum of \$5,000 for the road fund.

Good roads always has been the chief aim of the automobile organization, which numbers 7,000 members, and on various occasions it had collected funds for road-mending; so, when the Providence road, as the highway between Media and Chester is known, had sunk along one section of a mile and an eighth into a deplorable condition, described by motorists as "Swiss cheese" because of the numerous holes, the club volunteered to help with its repair.

The township long ago had announced that it had exhausted all its available

money for road improvement and the club agreed to help finance the highway's reconstruction as soon as the State decided that it could not assist, because the road is not listed in the Pennsylvania primary system, and the county in which it lies—



Along the Midway of the circus, which netted \$5,000 for the Providence road.



This Armco culvert was used in the reconstruction of a wooden bridge in Fresno County, Calif. Supervisor Robert Lothead is seated on the head wall.

Delaware—showed that its exchequer was empty from reconstructing roads antedating the poor condition of Providence road.

Even had the Providence road been listed in the State's primary system by a special act of the legislature, it would have had to await its turn on a long list. But only thirty-five per cent of the highways originally designated as forming the primary system of roads have been constructed. This means it would have been perhaps years before the State could do anything to reconstruct the thoroughfare, even though it had become a menace to motorists and teamsters.

"But what can be done in the meantime to make that road safe?" people kept asking. There was much "hemming and hawing" and meditative stroking of beards. Then the township road commis-

sioners, the county commissioners, the State Highway Department automobile division and the Keystone Automobile Club's representatives held a get-together meeting and mulled over the situation. J. Borton Weeks, president of the automobile club, on behalf of the organization, offered \$1,000 from the treasury. As no other help seemed forthcoming, the club representatives saw it was up to them.

Now it happened that the Keystone Club had been planning a celebration of the fifteenth anniversary of its founding. "Why not combine this celebration with some big sort of feature to raise money for this much-needed road improvement?" was asked. Bingo! Action followed. "Lew" Walters, a director of the club, suggested a circus—not the usual club kind, but a bang-up, elephant-and-monkey three-ring affair, with pink near-hooch and all the other time-honored accessories. A site was chosen for the show on land facing Providence road, at Palmer's Corner, in Wallingford, next the Spring Haven Country Club's domain.

Just as a bit of publicity that would stick, it was so maneuvered that everybody attending the circus would have to ride over that notorious mile and an eighth of "Swiss cheese roadway." This would carry its own appeal.

And then "Lew" Walters was dispatched circus-chasing. He roped, tied and branded a large one in Georgia, purchased it and wired back that the show would give four performances at Wallingford, in two days.

The circus was a "regular" one in every sense. Even the most sanguine members gaped when the wagons loomed up. There were five elephants, one hundred and twenty horses, five cages of wild animals, jaunty riders and all the side-show phases that ever tickled a peanut-eating audience into guffaws.

While it was out for business, the club did not forget deeds of kindness. For instance, 1,000 orphans—count 'em —1,000—were guests of the organization at one of the performances.

The attendance for the four performances on the two days approximated 15,000 and at the Saturday matinee more than 1,000 automobiles were parked in the adjacent fields.

The Traffic of the Future—What Will It Be?

H. G. WELLS, the Noted Writer, Looks Down the Highways of Tomorrow

Twenty years ago, H. G. Wells wrote a startling book entitled "Anticipations." In it he dealt with "Locomotion in the Twentieth Century," and made certain prophecies. Many of these anticipated developments have come true, and those who have a part in the spending of the millions of dollars appropriated for highway construction would do well to consider seriously what Mr. Wells has to say, as herewith summarized

PASSING over Mr. Wells' description of the adoption of the steam engine as a motive power for vehicles to take the place of the stage coach, we find him taking for granted the present-day development of the automobile, and looking into the future. We find him considering the kind of traffic our highways must carry and the type of roads necessary to support this traffic. And remember these were "anticipations" of twenty years ago!

"Let us consider," writes Mr. Wells in speaking of the traffic of the future in relation to the predominant railway traffic of 1902, "what other possibilities seem to offer themselves. . . . The abounding presence of numerous experimental motors today is so stimulating to the imagination, there are so many stimulated persons at work upon them, that it is dif-



H. G. WELLS

"The best known writer in the world" saying good-bye after reporting the Disarmament Conference. Read what he says about roads and traffic.



Will the bicycle "come back" with bigger tires? Will this vehicle form part of the traffic of the future?

icult to believe that the obvious impossibility of most of them, their convulsiveness, clumsiness, and—in many cases—their exasperating trail of stench will not be rapidly fined away. I do not think it is asking too much of the reader's faith in progress to assume that so far as a light powerful engine goes . . . the problem will very speedily be solved. And upon that assumption, in what direction are these new motor vehicles likely to develop? How will they react upon the

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railways? And where, finally, will they take us?

"At present," continues Mr. Wells, "they seem to promise development along three distinct and definite lines.

"There will, first of all, be the motor truck for heavy traffic. Already such trucks are in evidence, distributing goods and parcels of various sorts. And sooner or later, no doubt, the numerous advantages of such an arrangement will lead to the organization of large carrier companies, using such motor trucks to carry goods in bulk or parcels on the high-roads.

"In the next place, and parallel with the motor truck, there will develop the hired or privately-owned motor carriage. This, for all except the longest journeys, will add a fine sense of personal independence to all the small conveniences of first-class railway travel. It will be capable of a day's journey of three hundred miles or more, long before the developments to be presently foreshadowed arrive. . . .

"And thirdly, there will be the motor omnibus, attacking or developing out of the horse omnibus companies and suburban lines. All this seems fairly safe prophesying."

Then, Mr. Wells points out, there will probably be special roads, for light and heavy, or slow and speedy traffic—roads on which great loads can be carried, as well as roads designed for light, fast-moving vehicles alone.

And then, says Mr. Wells: "We may hazard some details about these special roads. For example, they will be very



Narrow roads cause traffic jams like this. Will the road of the future be made wide enough to accommodate two lanes of traffic, one for slow-moving freight, the other for speedy pleasure cars?

different from our macadamized roads; they will be used only by soft-tired vehicles. . . . It may be that they will have a surface like that of some of our cycle-racing tracks, though, since they will be open to the wind and weather, it is perhaps more probable that they will be made of very soft asphalt, sloped to drain, and still more probable that they will be made of some new substance altogether—whether hard or resilient is beyond my foretelling. They will have to be very wide—they will be just as wide as the courage of their promoters goes—and if the first are made too narrow, there will be no question of gauge to limit the later ones. Their traffic in opposite directions will probably be strictly separated . . . and where their ways branch, the streams of traffic will not cross at a level, but by bridges."

How very accurately this 20-year-old prophecy has been fulfilled!

It should be noted that Mr. Wells did not feel able to prophesy the type of road surface best suited to meet the type of traffic he saw in the future. Can we, today, foresee, what type of road will serve? No, because we cannot tell what the traffic of the future will be like. But we can be certain, as Mr. Wells was certain twenty years ago, that the motor-driven vehicle will constitute the greatest volume of traffic on our roads, and therefore we should build the foundation of our highways with that idea in mind. Adequate width—at least as wide as the widest now designed—solid foundation and proper drainage are fundamental principles, if we are to build for the future.



The old "Pioneer"—a vehicle of yesterday—the first locomotive on the Chicago & North Western. This "old timer" was in use in 1848.

What Two Men Did When Road Funds Failed

By J. P. ISON

Secretary, Bernice Chamber of Commerce, Bernice, La.

How borrowed machinery, a few farm hands and a "we will" spirit built a road at no cost to the public.

THE motto of the town of Bernice, La., is "Where Education, Commerce and Agriculture Meet." They are thinking of adding another phrase, "The Spirit of Service," as the result of a piece of highway construction that marks a new record for public spiritedness.

Ward Eight, Union Parish, Louisiana, was the first in the Parish to build and maintain its roads by taxation. The system has been installed less than four years yet the Parish has nearly completed a system of the best dirt roads in the state.

REBUILDING NECESSARY

Owing to the great tumble in the price of all commodities, especially cotton, Ward Eight found itself bankrupt last year along with many other sections of the south and unable to carry on much needed improvements.

One section of road that was badly in need of rebuilding is on the highway running between Bernice and Dubach, near Middlefork Bayou at what is known as the Double Bridges, or Jones' Crossing.

The bayou divides into two streams about a mile above the Crossing, forming a swamp nearly a mile wide. It is prac-



A section of the road through Middlefork Bayou, near Jones' Crossing. The photo shows the crushed stone which was hauled from neighboring fields and broken by hand.



Part of the crew that built the stretch of swamp road between Bernice and Dubach, La. J. A. Lowery and W. J. Owens, two plantation owners, gave their services and the entire working force of their plantations to build the road, at no cost to the public.

tically flat, and, during the rainy season and at periods of high water, this mile of low land between the two streams is overflowed to a depth of from two to four feet. The road runs straight through this swamp. The streams are very sluggish, there being little current, and none at all where the swamp is overflowed.

This permits of the road being built up to where it can be travelled at any time, but owing to the soil being of a gumbo nature it becomes soft and boggy during the rainy season. To overcome this it was necessary that the crown of the road be paved in some way.

As this road will prove to be the most feasible route for the Pershing Highway, effort was made to have this work done. An appeal was made to the Road District Commissioners for aid, but the finances of the Parish would not allow for the carrying out of the project.

NO COST TO THE PUBLIC

Then it was that two men, J. A. Lowery and W. J. Owens, living near Double Bridges, stepped into the breach. It had long been the cherished hope of these two men to see a real road built through this swamp.

Knowing that they could expect no aid from any source, but not to be put off any longer, they started in building the road after "laying by" their crops. With borrowed machinery and the few hands who worked their farms, they first built up the road-bed about 12 to 18 inches.

They then hauled rock from the adjoining fields and hillsides spreading the rock evenly over the road bed, so that when crushed or broken with sledges the bed would be perfectly level. Another layer of dirt and gravel was spread over the crushed rock which was rolled and graded, forming a perfect road.

Lowery and Owens put in one of the most strenuous summers of their lives, but they have succeeded in building the foundation of what has proved a model road, passable at all times through Middleford swamp, which, if properly maintained, will endure for many years.

The road cost no one a dollar except these two men whose only reward is in the knowledge of altruism and work well done in the face of a very real problem.



One way to cheat the death toll, due to carelessness in auto driving. The young folk of Atlanta were enlisted, and the number of deaths on highways has been materially reduced.

A Unique Warning Sign

THE Junior Chamber of Commerce of Atlanta, Georgia, recently put on a Safety Week Campaign, intended to reduce the number of accidents in Atlanta, especially automobile accidents, which are rapidly increasing.

A ceremony was held in which "old man carelessness" was buried and a monument was erected, which is reproduced in an accompanying illustration.

Wooden crosses were erected at points on the highways where people had been killed on the highway in accidents.

Tennessee to Spend \$7,500,000

ROAD work in Tennessee during 1922 will involve the expenditure of more than \$7,500,000. This includes completion of work under contracts now awarded that will aggregate \$5,000,000.

South Dakota Pushes Engineering Education

By W. B. WANDT

Professor of Civil Engineering, South Dakota State School of Mines.

THE State of South Dakota has added another splendid building to its list of buildings used for educational purposes. The new \$130,000 Engineering Building at the State School of Mines, Rapid City, has been completed by the contractors and accepted by the Regents of Education.

This building is three stories in height and is absolutely fireproof in its construction, the walls being of stone and brick and the floors of reinforced concrete. The floors of the halls and vestibules are of terrazzo, the commercial name for a concrete that uses marble chips in place of crushed stone. The stairs are of marble as are also the trims in the halls and vestibules. The building has a frontage of 140 feet and the greatest depth of the wings is 70 feet. The building is well designed and constructed throughout and will add greatly to the efficiency of engineering instruction at the School of Mines. The engineering departments located in the building are civil engineering and electrical engineering.

The civil engineering laboratories consist of a cement and concrete testing laboratory, a road materials testing laboratory, and a general strength of materials testing laboratory.

CEMENT AND CONCRETE TESTING LABORATORY

This laboratory is equipped for making standard tests upon cement and upon concrete aggregates. The equipment consists of a tension machine, Vicat appara-

tus, Gillmore needles, specific gravity flasks, electric drying oven, soundness steamer, moist closet, fineness scale, sand scale, triple beam balance, several sets of standard sieves, and a supply of sand molds, trowels, graduates and the necessary smaller equipment.

ROAD MATERIALS TESTING LABORATORY

This laboratory is equipped to make physical tests upon sand, gravel and stone to determine their fitness for use in road construction. The equipment consists of one Deval abrasion machine, one ball grinding mill, one cementation briquette former, one impact machine for cementation tests, one set of stone screens, one Ro-Tap machine, one Troemner scale, and other smaller auxiliary apparatus.

GENERAL STRENGTH OF MATERIALS TESTING LABORATORY

This laboratory has for its object the determination of the general physical properties of the materials of engineering construction, such as the tensile, compressive, shearing, and bending strength of wood, iron, steel and concrete.

ELECTRICAL ENGINEERING LABORATORIES

The electrical laboratories consist of the main dynamo laboratory, storage battery room and wireless station room in the basement. The laboratories on the first floor are devoted to standardizing and calibrating, photometry, and telephone and telegraph work.



Where the future highway engineers of South Dakota are being trained. The new \$130,000 engineering building at the State School of Mines, Rapid City, South Dakota.

Unique Use for Corrugated Iron Culverts

Washington County Engineer installs Armco Culverts as piers to render bridge safe for increased loads.

W J. Sisson, County Engineer of Garfield County, Washington, who contributed an article to *the Highway Magazine* last January on "The Farm-to-Market Road" has recently installed four Armco ingot iron culverts as bridge piers in Garfield County.

A forty-foot span bridge was erected in 1916 across North Dedman Creek. The structure was sustained by four, 6 by 8 timbers at each end. The creek having washed its channel down to bedrock, it was found that the bridge had become unsafe.

As the county did not feel in a position to replace the bridge, a stable and economic means of making it safe for traffic was sought, and it was finally decided to use Armco corrugated culverts filled with concrete for piers.

Four, 12-inch, 16-gauge culverts were embedded in a concrete base 18 inches deep, with anchor bolts set in each to anchor an 8/8 cap for the sills to rest on, at each end of the bridge. The height above the bed of the channel to the floor beams is 14 feet.



Armco culverts used as bridge piers, made this bridge safe for heavy traffic.

This installation has given satisfaction both from the standpoint of service and economy of construction.

When a more lasting superstructure is built, it is not unlikely that the Armco culvert piers will remain as they show no signs of corrosion or wear.



These 36-inch Armco ingot iron corrugated culverts, set over piling, filled with concrete, have successfully supported this heavy bridge and withstood the buffeting of heavy ice and floating logs for the past five years. Note the corrugated iron used as the foundation of the bridge floor.

Irrigation and Drainage

Canadian Power Development

A gigantic flume canal is now being built at Niagara Falls



Airplane view of the Chippawa-Queenston development of the Hydro-Electric Power Commission of Ontario, showing canal, diffuser, forebay, gatehouse, penstocks and powerhouse.

READERS of *Highway Magazine* who are resident in the Province of Ontario or New York State are familiar, no doubt, with the various projects centering around Niagara Falls for the development of electric power. This locality, and the waterway beyond to the Atlantic, has taken on, during recent months, a continent-wide interest in its relation to improved water transport and further power development.

The sketch reproduced on page 14 will show the scene of activity in Canada and the course of the Chippawa-Queenston colossal undertaking. From the intake at Chippawa above Niagara Falls to the power house at Queenston on the Niagara River, a canal $12\frac{3}{4}$ miles in length was constructed. The first $4\frac{1}{4}$ miles follow the route of the Welland River, and the remaining $8\frac{1}{2}$ miles of canal is dry excavation in earth and rock. The lower end of the canal opens up into a triangle

shaped forebay cut into the rock at the top of the cliff near Queenston.

The following general data indicates the scale of the construction operations.

Installed capacity for 9 units.....	500,000 H. P.
Effective head	305 feet
Capacity of each unit.....	55,000 H. P.
Length of river section.....	4 miles
Length of canal.....	9 miles
Deepest cuts.....	72 ft. in earth and 85 ft. in rock
Greatest cut, combined earth and rock.....	145 feet
Width of finished water channel.....	48 feet
Depth of water under normal operation.....	35 feet
The maximum velocity in the canal will be 10 ft. per second. The forebay, 1,000 ft. long, widens from the standard canal section to 500 ft. at the gate house.	
Diameter of steel penstocks.....	16 feet
The power house when completed, will be nearly 700 feet long, and 185 feet high from the base.	
Total earth excavation.....	13 million cu. yds.
Total rock excavation.....	4 million cu. yds.
Work was commenced.....	May, 1917
Canal was put into service.....	December, 1921

The waters of Superior, Michigan, Hu-

ron and Erie, harnessed at Queenston for man's needs, emerge from the Niagara River into Lake Ontario, then narrow as the St. Lawrence on the final stretch to the Sea. Here, on the St. Lawrence, man designs that the waters shall grind again. Westerners in the two countries are inter-

ested in the Great Waterways Scheme that will make possible for ocean-going vessels to load cargo at Chicago, Duluth, Ft. William and Pt. Arthur, the products of the great Interior. A by-product of 4,000,000 electric horse-power may finance the enterprise.



Bird's-eye view of Queenston-Chippawa development, showing intake from Niagara River above the Falls, with Welland River section in foreground.

Solving a Land Drainage Problem

By DON HEATON
Surveyor and Civil Engineer

The author has made a study of drain pipe failures, particularly at points of outlet, and herewith gives one solution and some interesting facts about an unusually bad failure in Indiana.

A VERY destructive washout recently occurred at the outlet of a 24-inch tile drain which, with its several branches, drained about 1,500 to 1,800 acres of Indiana land.

In all, the pipe was about four miles long, and poured its water into a large open ditch.

The installation was made in 1910, and at that time a concrete wall was constructed at the outlet.

Recently, a wash fifty feet long, thirty feet wide and seven feet deep occurred at this outlet point. The large headwall toppled over, and a glance at the accompanying illustration shows the other disastrous results of the washout.

This case is a typical maintenance problem on tile drains. This large washout was not caused from any wash from surface water. What happened in this case and what usually happens is about as follows: A comparatively heavy concrete wall is usually placed at the outlet



This destructive washout was caused by the failure of a 24-inch tile drain, the outlet of a system which drained 1,800 acres of farm land.



Repairing the damage done by erosion through the failure of a 24-inch tile drain. Photo shows forms for new headwall and a 24-inch Armco culvert pipe in place.



The finished job. Neither shifting earth nor frost action will injure this 24-inch Armco ingot iron corrugated culvert which now connects the tile drain with the outlet wall as described on this page.

of the drain. This wall settles more than the tile that connects with it, with the result that a crack or opening is made in the tile drain just above the wall; dirt begins to sift through this crack, and eddies formed in the current within the tile begin to erode the dirt through this crack at the sides of the tile. Before long a tile gets completely out of alignment, allowing more dirt to get in the tile, and soon there is an opening from the surface, then freezing and exposure greatly accelerate the disintegration, and in a comparatively short time (2 to 5 years) you have a condition shown in the pictures.

Even without any settlement of the wall, this bad condition is sometimes started by freezing and breaking of the drain tile near the outlet on account of the proximity to the cold air of the ground surface. Also poorly laid tile (poor alignment) near the outlet of the tile drain, is very often a contributory cause to these washouts.

A permanent solution for this kind of failure is to have about 20 to 50 feet of strong, continuous pipe of some kind connecting the tile drain with this outlet wall. This eliminates any danger from frost action or cracks being opened by settlement of the retaining wall.

In this case, 50 feet of 24-inch Armco culvert pipe, extending through a retaining wall 40 feet long, was installed.

Construction on Skagit Project

FOLLOWING the approval of the Seattle city council, of a \$5,500,000 bond issue for the Skagit River hydroelectric project, Chief Engineer C. F. Uhden in charge of the work, is starting construction work on the 11,000 foot tunnel to carry water from the dam site to the power house at Gorge creek. The construction of this tunnel, which will be driven through solid granite, and which will be 23 feet in diameter, is the largest single undertaking in connection with the development of the Gorge Creek unit, of the Skagit Development. This work alone is estimated to cost approximately \$2,000,000.

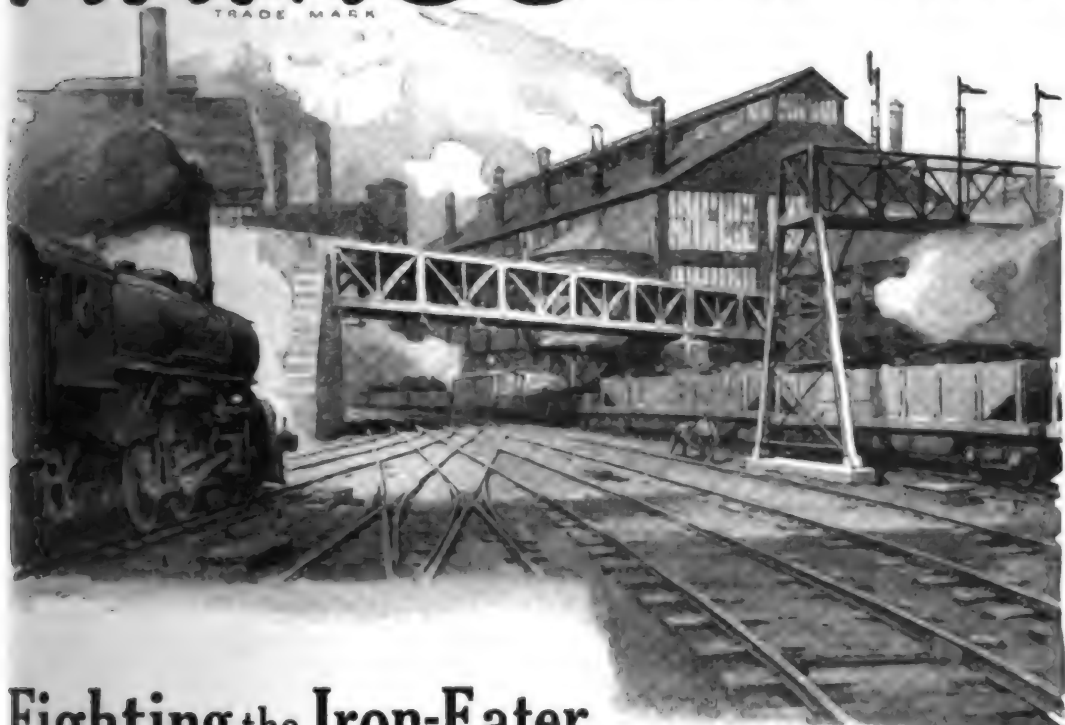


Water for Crops First

THE Kennewick Irrigation District, at Prosser, Wash., has won a victory in the Benton County Court through a decision, rendered by Judge Mills, sustaining the irrigation district's claim that the need of water for irrigation purposes is superior to the requirements of a flour mill, electric plant and other private interests involved, for which reason he granted an order of necessity and permitted condemnation of the Prosser Falls dam. About 35,000 acres of irrigable land will be benefited.

ARMCO INGOT IRON

TRADE MARK



Fighting the Iron-Eater

ONE cannot think of a railroad without bringing to mind numerous forms of iron and steel essential to its operation, which in practically every instance are exposed to the elements.

To successfully combat rust, the great iron-eater, railroad engineers and executives have tried scores of expedients with varied success, but the one metal which has universally given satisfaction is ARMCO Ingot Iron. Its purity and homogeneity prevent the very action which causes rust.

ARMCO Culverts have been adopted by many of the leading railroad engineers because they resist the destructive action of rust and vibration. Highway Engineers can profit by the experience of their brothers who have been studying the problem for years. Write us for valuable data on conservation of metal.



The American Rolling Mill Company

MIDDLETOWN, OHIO

These Men Know the DURABILITY of Armco Culverts



For Fifteen Years—

the men who maintain the right-of-way of this heavily-traveled railroad have inspected ARMCO Culverts.

Many of these sturdy structures of corrugated ARMCO Ingot Iron have been under the rails from five to fifteen years and show no signs of deterioration, according to reports on file in the office of the general superintendent.

Because of their strength and elasticity, these ARMCO Culverts have withstood the hammer of heavy trains with only a shallow protecting fill.

Because of their basic purity of metal, they have resisted corrosion during more than a decade of service.



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and prices on ARMCO (American
Ingot) Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
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Missouri, Moberly
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North-East Metal Culvert Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

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Oregon, Portland
Coast Culvert & Flume Co.

Pennsylvania, Warren
Pennsylvania Metal Culvert Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
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Spokane Culvert & Tank Co.

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Canada

Canada Ingot Iron Co., Ltd., Guelph, Sherbrooke, Winnipeg, Calgary.

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A wonderful section of the Columbia River Highway, cut from a solid rock cliff, overlooking the Columbia River, near the approach to Mitchell Point Tunnel.



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Connecticut "Cops" to Patrol the Roads

A COMPREHENSIVE system of patrols to cover the main highways of Connecticut will soon be put into operation by the State Police Department. In the height of the motoring season about three thousand miles of Connecticut highways will be patrolled by the state police force. It is the intention of Superintendent Hurley of the state police to do everything in the power of the department to make travel over Connecticut highways the safest in New England.

"The Vanishing Race"

"EVERY city," says a trade journal, "is face to face with the problem of widening its streets."

Given time, according to the Detroit Motor News, the problem will settle itself. In a few more years the sidewalks can be taken up and given over to vehicular traffic. There won't be any pedestrians left.

Don't Blame the Editors for This!

SOME business men do not believe in advertising. Take a tip from Sampson. He had the right idea about advertising. He took two columns and brought down the house.

West Virginia Improves Important Road

THE Virginia State Highway Department has started work of improving the road between West Norton and Appalachia with convict labor. The grade will be reduced, a number of sharp curves eliminated and the road widened to 16 feet. Surveys are also being made on the road between Norton and West Norton and the contract for paving with concrete will be let shortly.

Ohio, Indiana and Michigan to Co-operate

AT a joint conference held in Columbus, Ohio, of the state road commissioners of Ohio, Indiana and Michigan, the highway situation of the three states was generally discussed.

As a result of the meeting an agreement was worked out whereby the three state departments will co-operate in the construction of highways across state lines, so that one state will have a dead end trunk line leading into another state.

Ice Cream Wagons Mustn't Drip in Trenton

THE Trenton, N. J., Department of Streets is conducting a campaign against ice cream wagons which allow salt water to drip upon the city streets, resulting in damage to the pavements. Trenton has an ordinance against allowing salt water to drip upon pavements.

Highway Engineers! 'Tenshun!

TAKE some pictures of that project that you are on and send them, together with a short description of the most interesting or unusual features of your job, to the Editor.

New York Breaks Road Record

THE State of New York spent \$28,775,886 on road construction in 1921, breaking all records for highway construction in the history of the state.

Wisconsin's Unique Team Patrol System

By R. E. BALLIETTE

Former Maintenance Superintendent, Calumet County, Wisconsin.

The author has had first-hand knowledge of the operation of the much-talked-of maintenance system employed by the State of Wisconsin, and herewith describes the team patrol division.

THE most important constructive road law ever passed in the Middle West, was enacted by the legislature of the state of Wisconsin in 1917. This was done in compliance with the Federal Aid Highway Act passed in 1917, and amended in 1919.

This law provides for a state highway trunk system of 7,500 miles, to connect all county seats and cities having a population of 5,000. All of the Federal-aid money, and half of the state and county funds, will go towards this trunk line, until the whole system is finished. The roads are to be mapped, marked, and maintained by the counties, under the direction of the state highway commission. The patrol system is the most modern in the country.

There are three methods of maintenance used at present: the team patrol, where the patrolman furnishes team and wagon, while the county furnishes the other tools; the light tractor grader patrol, where the patrolman furnishes the tractor, and the county the balance of the equipment; and, lastly, the truck patrol, where the county furnishes the entire outfit, and an assistant to help the patrolman.

As an aid to the above systems, there is added the gang maintenance, usually in charge of a county foreman, which aids the different patrolmen in work that is too difficult for the patrolman.

The lengths of the systems vary, according to the type of maintenance, as follows: about 7 miles to the team patrol; 13 to the tractor grader, and between 18 to 20 miles to the truck patrol.

The most common and interesting type is the team patrol. These typical road workers, are hired for a period of 8 months in the southern counties, and 7 in the northern counties. They are carefully selected with the view of getting as good men as possible. They are paid as high wages as can be afforded, in order to get *real* men, who are dependable; who can "use their heads" as well as their hands. The state desires honest, sensible, even-tempered, healthy and willing men.

Their outfit consists of a good strong team and wagon, furnished by the patrolman, while the county supplies the grader, and all small tools, such as, bar, shovel, chain, pick, slip scraper and scythe. The men are charged with the



One of Wisconsin's team patrols on the job. Note the patrolman's number painted on the side of the wagon, which he furnishes. The County supplies the tools.

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care of the equipment, and must give a strict account of same at the end of the season.

The duties of the patrolman are various, and can best be noted under the following heads. The patrolman must—

1. Execute a bond to the county in the sum of \$500, for the faithful performance of duties, and care of his equipment.

2. Give his entire time to the county during the season.

3. Furnish a team and satisfactory wagon to the county.

4. Be responsible, at the county's expense, to keep all his equipment in good order.

5. Properly grade and drain the road surface, keep the grass cut back from the shoulders, maintain a proper crown, and keep the surface smooth and even, by the use of the light grader.

6. Provide additional drainage away from the road ditches, where necessary, and keep all culverts and ditches open.

7. Remove weeds from the road to the fence, by mowing twice a year (before seed time) with a mower, and also clear out the brush where it interferes with the vision at curves.

8. Add new material to the surface if necessary.

9. Cut grass around signs and culvert ends.

10. Protect side banks and fills by seeding, or sodding.

11. Construct and repair guard fence, also rip rap where wash is apt to occur.

12. Properly maintain all signs and markers, as well as detours around construction work, and keep all signs in place.

THE REPORT CARD SYSTEM

Patrolmen are under the direct supervision of a maintenance superintendent appointed by the county highway commissioner, or under him directly. All work must be reported daily, on cards sent in to the county seat, and a monthly report sheet, which must balance with the daily cards, must be turned in. The daily cards must show the hours worked; the location mile to mile of work done, and nature of same; weather conditions; expenditures

made, and any other information needed by the county office. Unless the above conditions are adhered to, no money will be forthcoming to the patrolman.

Every patrolman wears on his hat or cap, a certain number, on an aluminum plate, which corresponds to the number of his section, and he also has this number, and the state highway marker, painted in the side of his wagon. This number, together with his name, is also on a post at the end of his section. This gives the public the name of the man responsible for the condition of the section.

PATROLMEN ARE RATED

Another feature is that of maintaining detours where the public are diverted from the regular road, due to local work, bad washouts, bridge construction and other causes. Signs are placed in conspicuous places and not too far apart. This is one of the most valuable services of a patrolman.

The patrolman is supposed to go over his section twice a week, rain or shine, with his grader, and in case of rain, as soon as possible afterwards, to fill in the low places and attend to the drainage. Picking up stray stones and putting them around culvert walls or narrow places is also constantly done. With the exception of rainy days, he must be on the job from 7 to 12, and 1 to 6. He will not be paid unless he puts in the hours called for in his contract.

Patrolmen are checked over carefully to see if they do their work properly. They are marked on the scale of excellent, good, fair and poor. In the year 1920, Wisconsin had 791 patrolmen, 159 of which were classed as E, 333 as G, 242 as F, and 57 P. The poor ones are weeded out and replaced by new timber. They have done wonderfully well, considering that so many are new to the job.

It is gratifying to see the pride the men take in their work, and the results they attain. They have an added stimulus in the shape of a \$5 monthly bonus for excellent work. In 1920, 633 received the bonus, and 161 failed to get it. The award is made by the officers of the system.

Government Gives Millions for Highways in the U. S. National Forests

Facts and Photos Supplied by F. E. BONNER,
Acting Chief Engineer. United States Forest Service.

Through the co-operation of the Forest Service, The Highway Magazine is privileged to print the sub-joined information about road construction in the National Forests under the \$15,000,000 appropriation.

INCREASED activity and a new impetus to the work of constructing National Forest roads and trails has resulted in the \$15,000,000 appropriation which has been apportioned among 27 states, Alaska and Porto Rico, for the present year.

This appropriation, forestry officials state, is making possible the work of



Motorists entering Glacier National Park through the new White River Gateway of the McClellan Pass Highway.

An adequate system of roads and trails throughout the National Forests will aid materially in fire protection. At present there are large areas of trackless wilderness within the Forests that cannot be reached by trails. When lightning storms sweep over these inaccessible areas, heavy fire losses of public timber often occur.

Speed in reaching a forest fire, foresters claim, is just as important in protecting the country's forests, as is speed in city fire protection. But high speed within the forests means four or five miles an hour over a mountain trail. If no trail exists it is often impossible for the fire fighters to average more than one-fourth of a mile an hour.

In the past, construction of many



An exceedingly deep cut through the solid rock on the Cooks-Collins road in the Columbia National Forest, Washington.

opening up vast tracts of valuable timber and areas of scenic beauty for the use and enjoyment of the American people.

The U. S. National Forests contain a total of more than 156,000,000 acres of land and embrace much of the most rugged, densely-timbered and least-developed regions of the country. The need for a complete system of roads and trails for the protection and development of these vast regions is obvious.



Tent camp with all the comforts of home. Tiogo Lodge, Mono National Park, Calif.



A section of the main highway constructed by the U. S. Forest Service along the Kootenai River, Lincoln County, Montana, paralleling the right of way of the Great Northern Railroad.

urgently-needed forest roads has been deferred for lack of sufficient funds. Much of this work of new construction is now going forward. The Forest Service estimates that eventually over \$100,000,000 will be required to supply a thoroughly adequate transportation system throughout the 156,000,000 acres within the domain of the National Forests.

The work of providing the necessary system of roads and trails in the National Forests has been progressing steadily since 1905 when the Forest Service became charged with the administration of these regions. Early appropriations, were, however, small and it was not until recent years that impressive progress has been made upon the work. Appropriations previous to that in the Federal Highway Act of November 9, 1921, consisted of \$19,000,000 under the acts of 1916 and 1919, and also a provision in an act of 1913 which permitted the Forest Service to use for improvements 10 per cent of the receipts each year from the sale of timber and other Forest products.

This latter fund has amounted thus far to slightly more than \$3,000,000. Under the past appropriations there has been expended about \$20,000,000, but a great deal of work remains to be done.

According to the best estimates prepared by the Forest Service there are about 5,400 miles of road still required to complete the state highway systems traversing the National Forests con-

tiguous to them. About 8,500 miles of roads are needed to complete the county highway systems within the Forests.

Additional roads, required principally for the protection and utilization of the resources of the National Forests, aggregate more than 13,000 miles. Aside from the roads the pack trails needed in this vast area, principally in connection with fire protection work, will entail about 40,000 miles of further construction.

HOW THE MONEY WILL BE SPENT

State	National Forest Highway Fund \$9,500,000	National Forest Development Funds \$5,500,000	Grand Totals
Alabama	\$ 4,880	\$ 5,799	10,679
Alaska	970,271	50,222	1,020,493
Arizona	598,189	280,722	878,911
Arkansas	70,365	72,573	142,938
California	1,460,871	703,822	2,164,693
Colorado	717,058	336,360	1,053,418
Florida	25,118	8,730	33,848
Georgia	13,355	20,347	33,702
Idaho	1,097,894	1,088,656	2,186,550
Maine	2,760	4,754	7,514
Michigan	3,638	6,220	9,858
Minnesota	60,929	65,621	126,550
Montana	878,886	574,615	1,453,501
Nebraska	11,065	11,159	22,224
Nevada	207,984	55,377	263,361
New Hampshire	35,204	24,276	59,570
New Mexico	458,258	219,652	677,910
North Carolina	27,856	46,984	74,840
Oklahoma	5,645	8,764	14,409
Oregon	1,157,109	718,555	1,875,664
Porto Rico	1,454	5,344	6,798
South Carolina	1,572	8,704	10,276
South Dakota	77,553	64,139	141,692
Tennessee	20,896	23,243	44,139
Utah	371,776	164,258	536,034
Virginia	26,140	46,512	72,652
Washington	708,133	602,889	1,311,022
West Virginia	6,051	14,602	20,653
Wyoming	479,000	267,101	746,101
Totals	\$9,500,000	\$5,500,000	\$15,000,000

Oregon County Court Practices Economy in Small Bridge Construction

How fifteen small wooden bridges on important roads were eliminated by the use of corrugated iron culverts.

COUNTY JUDGE J. W. GOODIN and County Commissioners J. J. Wismer and John Ireland, who compose the County Court of Washington County, Oregon, are eliminating a very big construction and maintenance expense on the numerous smaller wooden bridges in their county by replacing these wooden bridges with large-sized corrugated iron culverts and making fills.

Experience has shown that it is necessary to re-deck or floor wooden bridges every four to six years. The cross beams and railings and the sustaining timbers only last from ten to twelve years, and even then it's quite often necessary to replace a broken plank in the flooring every year or two. It was found that while the expense of a single plank itself was not very great, quite often this plank had to be transported four or five miles from the saw mill to the bridge, which took a man and an expensive team possibly a half day to replace this one plank.

During the spring freshets, when the water is high, these wooden bridges had to be constantly watched to see that their foundations were not undermined

by water or their underpinning knocked out by floating logs. If the wooden bridges were not kept in constant repair, there was always possibilities of damage suits, and even the loss of lives.

During the last year this court has replaced about fifteen wooden bridges



A 60-inch, 12-gauge Armco culvert 20 feet long, which replaced a wooden bridge at Metzger, Washington County, Oregon.



The fill which replaced an old wooden bridge the same length as the sidewalk bridge at the left. Under this fill is the 60-inch Armco culvert shown above.



The old wooden bridge on the Scholls Ferry Road, which was replaced with two 72-inch Armco culverts pictured below.

with corrugated culverts made from Armco ingot iron. The bridges were from 10 feet to about 120 feet long. The culverts used ranged in size from 36 inches in diameter to 72 inches in diameter.

On the Scholls Ferry road was installed a battery of two 72-inch corrugated Armco ingot iron culverts made of 12 gauge metal, 50 feet long. At one end of this wooden bridge location, the road had a steep grade of about 15 per cent. This grade was cut down to about 6 per cent and the earth used to make the fill, thus killing two birds with one stone.

Another bridge, located at Metzger, was in such poor condition that it had to be condemned and signs posted to

that effect to eliminate the possibility of paying damages. It would have been very expensive to have replaced this bridge with a new one. Instead a 60-inch corrugated culvert, 20 feet long, made from 12 gauge Armco ingot iron, was installed and a fill made.

The experience of this court has proved that when a wooden bridge is replaced by corrugated culverts of sufficient diameter to take care of the water in the stream, and the proper fill made, that maintenance expense, and the future care of the bridge is eliminated, and that the amount saved by elimination of the maintenance expense pays a very big interest on the investment and gives a road bed on which can be placed a hard surface any future time.

This county has recently asked its district road supervisors to furnish a complete list of all wooden bridges in the county that have begun to deteriorate, and it is with the intention of replacing these bridges at once with corrugated iron culverts of sufficient diameters to take care of the water.

The officials of the county declare that the service given the county by corrugated culverts made from Armco ingot iron during the last twelve to fifteen years is so satisfactory that they hesitate to experiment on other types of material.

The accompanying pictures illustrate two of these bridges, prior to their replacement and after their replacement with corrugated culverts.

The county court feels that this is a problem that every county in the United States has to contend with and believes that their solution is the economical and permanent method of handling it.



These twin Armco culverts, 72 inches in diameter and 50 feet long, replaced the old wooden bridge on the Scholls Ferry Road, shown at the top of this page.

Maintenance of Hard Road Surfaces Other than Gravel

By E. S. ALDERMAN

State Highway Engineer of Oklahoma.

This is the third of a series of articles by this authority which have appeared in Highway Magazine. It contains, like those previously featured, many valuable suggestions.

THE gang and patrol systems have been explained in previous articles. Though the patrol system is recommended, either system, or a combination of both can be made to give satisfactory returns. No matter how good the pavement may be, a patrol can always find necessary work within its precinct, and the better the road the more can be economically cared for by each patrol.

Of the higher types of pavements, built and under construction, concrete ranks first in mileage, then comes concrete with bituminous wearing surface, concrete with brick wearing surface, bituminous macadam, shale, etc.

The maintenance of shoulders, ditches and drainage structures has been discussed in the preceding issues. The shoulders of the road should be kept flush with the top on the outer edge of the pavement. Joints and cracks in cement-concrete pavements should be thoroughly cleaned of all dirt or foreign material by using iron hook and wire or rattan push brooms, followed by the ordinary house broom to remove the dust.

When the cracks and joints are small, they should be completely filled with asphalt or tar filler. Tar at a temperature of about 200 degrees Fahrenheit, or hot asphalt with a penetration of 40 to 60, should be poured into the openings by hand, using a pouring pot with a narrow spout. After completely filling the cracks, cover at once with clean, coarse, dry sand or stone screenings. In heating the tar, care should be taken to avoid overheating and the tar in the bottom of the kettle should be cleaned out occasionally and thrown away. Owing to the brittleness of tar when frozen or used after being burnt, it is not as durable and asphalt may be found to be more economical.

A tar mastic filler, composed of a hot mixture of fine-grained dry sand and



E. S. ALDERMAN,

State Highway Engineer of Oklahoma.
The accompanying article, the third of a series, is contributed by Engineer Alderman.

tar at about 200 degrees Fahrenheit, may be used for the same purpose. The pouring pot is filled about half full of hot tar, the sand sifted into it and thoroughly mixed by stirring. Heated sand is recommended to prevent the mixture from cooling too rapidly. The amount of sand used will be that amount which will permit of easy pouring and it will vary from one-half to equal amounts of sand and tar. A mastic filler does not run in hot weather as does the tar filler.

Where large cracks and joints are to be filled, they should be thoroughly cleaned. The edges of the cracks or joints should be painted with hot or cold tar (or hot asphalt) to a depth of one inch or more and back sufficiently far on the surface to cover the ragged edges. The opening should be filled with a mixture of broken stone and

bituminous binder, using enough binder to fill voids in the sand and covering this material with a layer of dry sand or stone chips all thoroughly tamped into place and rolled or otherwise finally compacted and brought to a uniform surface with the rest of the pavement. The stone and bitumen should be mixed at a temperature of about 240 degrees Fahrenheit. The bitumen used may be asphalt or tar, according to Oklahoma State Highway Department Standard Specifications, pages 50 to 54.

Large openings and cuts through concrete pavements may be repaired by placing concrete of the same mix in the opening on a well compacted (tamped) subgrade. The concrete should be well tamped and finished off flush and brought to a uniformly smooth surface with the rest of the pavement.

When a concrete joint heaves and makes an objectionable bump, cut out the pavement on the high side for about eight or ten inches and trim the low side so that the opening will have a vertical surface to receive concrete, as explained in the preceding paragraph for large openings.

When a slab settles below grade, divert the traffic so that the slab may be jacked up to grade and the subgrade can then be thoroughly refilled and tamped to provide support at the required elevation. In order to accomplish this backfilling properly, it may be necessary to enlarge the excavation beneath the slab; and after jacking the

slab up to grade, the slab should be thoroughly timbered to keep it there and the jacks can be removed. The subgrade should be carefully backfilled, using earth or sand, free from perishable material, carefully tamping every bit of material which is replaced.

Old concrete pavements may be widened. Where pavements have shown themselves to be too thin, or the surfaces become worn and rough, the widening and the resurfacing may be done simultaneously.

The effect of temperature changes on a concrete pavement may be reduced by macadamizing the shoulders. This also provides more surface available for traffic and reduces the maintenance on the shoulders.

The maintenance of bituminous and brick pavements will be treated subsequently.



A Beautiful Road

THE cover design on *Highway Magazine* for this month shows a section of concrete road in Pennsylvania, which was recently constructed as Federal Aid Project No. 12.

The photograph from which this cover design was made was secured through the courtesy of the Bureau of Public Works.

Pennsylvania has been noted for its interest in good roads ever since Benjamin Franklin, long before the Revolutionary War, agitated for wider, cleaner roads in Philadelphia.



A well-maintained stretch of road on the Yellowstone Trail between Hudson and Eau Claire, Wisconsin. This highway runs through a rich farming country and is the means of bringing the markets nearer to the farmer.

Tourist Bureaus Make Yellowstone Trail Nationally Popular

By F. C. FINCH

Field Representative of the Yellowstone Trail Association

How twelve free road information bureaus, established by the Yellowstone Trail Association in twelve different cities, as well as two traveling information bureaus, are making this highway nationally popular with the tourist.



Two remarkable photographs of the double hairpin turn at Snoqualmie Pass, Washington, on the Yellowstone Trail. The one on the left, taken in mid-winter, shows how this mountain road is kept open, in spite of heavy snowfall. The one on the right shows the same scene taken six months later.

THE information bureau system of the Yellowstone Trail Association is complete in every department; entirely free to the public, and designed solely for help and service to tourists. This is the only organized highway having such a system of distributing information and giving personal service to motorists.

During the active touring season free road information bureaus are maintained by the Association in the larger cities along the route. Paid employees, trained in the work, are on duty at these offices.

In 1922 the information bureaus will be located at Cleveland, Ft. Wayne, Chicago, Milwaukee, Saint Paul and Minneapolis, Aberdeen, Miles City, Billings, Butte, Missoula and Spokane, all operated from the General Offices in Minneapolis in charge of a Director of Bureaus. This year marks the sixth the Association has conducted such a system of bureaus, and their value has been well established.

Their purpose is to give assistance to tourists in any way possible. Maps of any route are given; the condition

of all roads kept up to date, and reliable information given at first hand. Advice is given on where to camp; hotel accommodations arranged for; mail looked after; lost parties brought together, and in general each bureau is a tourist headquarters.

For instance, let us say one went into the Yellowstone Trail Cleveland Bureau for information on a trip to Seattle. Complete information is given him; maps, guides, route folders and the like are supplied. He is told the exact road conditions as far as Ft. Wayne and referred to the bureau in that city. Upon arrival at Ft. Wayne he presents an introductory card given him by the Cleveland office. The Ft. Wayne Bureau gives him data and information on the road to Chicago or Milwaukee. Thus, from bureau to bureau, he is cared for, clear to the Pacific Coast. This service is entirely free to the public. Bureau employees are forbidden to accept tips. Polite, energetic, and dependable young men will greet the tourist at each bureau. In giving routings the shortest and best route to the destination desired is adhered to, and the bureaus always keep a supply of maps of every route in the country on hand, giving them out as the occasion arises.

Through action taken by the Execu-



An Armco culvert draining a newly graded section of the Yellowstone Trail in Western Minnesota. Adequate drainage has made this highway leading to the West a tourists' delight.

tive Committee at the last annual meeting, the Association will have two traveling information bureaus in 1922, housed in specially built automobiles. These cars will be on the Trail all summer and will be traveling guides, assistants, and information bureaus to tourists traveling the Yellowstone Trail. They will also keep the road marked, and checked, report on camp sites along the Trail, as well as road conditions and other important data. One of these cars will be east of the Mississippi River, the other west.

The purpose of the Association is to encourage the building of a connected road serving the northern part of the United States. It spends no money in actual construction work, believing that the only real reason for using public money in the improvement or maintenance of a certain road, is intense use. Therefore it interests itself in travel, and particularly long distance travel, crystallizing attention to its whole interstate route, and pointing out to the public officials who have the expenditure of money for the building of roads the thousands of cars daily driving over it, and that it must be built and maintained to meet these travel demands. It is organized like a Chamber of Commerce or Commercial Club, with its marked route, its main street, and the towns along the way its business houses. Ray Smith, a prominent business man of Milwaukee, is president.

An indication that the 1922 automobile touring season will be a big one is found in the Automobile Tourist Register of the Yellowstone Trail Association kept at the Twin City Automobile Show during the week of February 4th to 11th, 1922.

A total of 678 parties that will actually take trips this summer made inquiry as to routes and information, totalling 1528 persons. Questions were asked by 2268 casual inquirers. Of the 678 actual traveling inquirers 138 will travel 3000 miles with more than half the distance over the Yellowstone Trail. 336 will travel about 1500 miles on the Yellowstone Trail; 96 parties will travel 1000 to 1500 miles on the same route, and 108 less than 1000 miles on this popular trans-continental route.



Irrigating Indian Lands

How the United States Indian Service is installing an irrigation system on an Indian reservation in California.

ALL the Indians of the United States have not been as fortunate as those in Oklahoma whose reservations, after years of unproductive aridity, suddenly spouted forth oil and made many of the Red Men millionaires over night.

Water, however, has long produced more wealth than even the most phenomenal gusher. In Oklahoma alone, where oil wells are brought in and fields extended almost daily, statistics show that the value of the state's farm products are five times the value of her oil output.

In California, where water is often spoken of as being "worth its weight in gold", irrigated farm lands are being allotted to the Indians.

The United States Indian Service has installed an irrigation system one and one-half miles southwest of Bishop, Cal., which will supply water for domestic and garden use on 80 acres of land which will be allotted to the Indians in two acre tracts.



A section of Armco ingot iron flume installed by the U. S. Indian Service one and a half miles southwest of Bishop, Calif.



Twenty-five feet of No. 24 (15.3 feet diameter) Armco ingot iron flume installed on the Indian Reservation at Bishop, California.

Ways of Increasing the Duty of Water

By W. L. POWERS

Oregon Agricultural College Experiment Station.

The value of water for irrigation purposes is measured by the value of the produce from the land on which it is used. This article deals with the problems of making water render the greatest possible service to its users.

DUTY of water is perhaps the broadest problem with which the irrigationists have to deal. As large projects develop, values increase, and more intensive methods become necessary, and the demand for economical use of water becomes more urgent, if the highest productive values are to be reached and the greatest production of the best quality of crops is to be maintained. Duty of water data is of value to water boards and courts in the determination and settlement of water rights; to engineers in fixing capacities of canals and reservoirs; to agriculturists in the control of soil moisture in such a manner as to produce the maximum net profits from agricultural operations.

A reasonable amount of water must be provided for each of the chief soil classes and for each important group of crops, according to their water requirement, average yields, and relative acreage on each project. This is desirable rather than to lump one flat rate for a great valley or project. Meadows constitute 52 per cent of the irrigated average on all Government projects, according to the Crop Census of the United States Reclamation Service. Meadow crops require about twice as much water as do annual crops, hence they deserve

about 75 per cent of the consideration in fixing an average duty of water for a given area.

The amount of water provided affects the estimates and final cost, determines the area it is possible to irrigate, and has its effect upon the security of investment in irrigation, and the ultimate agricultural and financial success of a project. Without control and economic use of the water resources, the fullest development and highest values will never be realized. To secure economical use of water on an irrigation project, and avoid alkali and drainage problems, there must be a good distribution system and each farmer must use water intelligently.

Too little water results in crop shortage, while excessive irrigation may lessen the crop and injure the soil in places to the point of unprofitable production. It is better economy to provide only a moderate allowance of water with reasonably priced structures, than to provide a liberal supply at a greater expense and invite drainage assessments later on. The aim should be to get the highest practicable efficiency out of every acre-inch of rainfall and every supplementary inch of irrigation water provided. The amount of water that will give the greatest net profit an acre will generally represent the limit of preventable loss under present economic conditions; as water becomes very valuable in places the net profit to the acre-foot will become of increasing importance.

A score of different factors affect the duty of water, and the factors affecting storage, conveyance and distribution losses and soil and crop requirements have been discussed in a previous publication of the Oregon Experiment Station. (Powers, W. L.—Duty of Water in Irrigation—Ore. Exp. Sta. Dept. Soils. Bul. 161, 1920.) It is the purpose of this paper to present some ad-

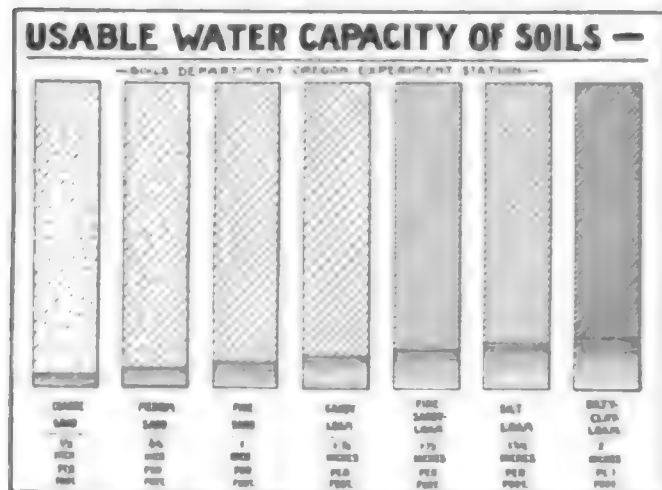


FIG. No. 1.

ditional data bearing on a few of the chief ways of increasing duty of water.

I. Usable Water Capacity of Soils. The field capacity of soils for storing usable soil moisture affects the amount and frequency of irrigation and total quantity required per season very much. In duty of water studies, it has often been found that farmers will apply six or eight inches of irrigation to a soil with capacity to retain not over four inches. The surplus removes valuable plant foods; may cause drainage problems on adjacent low lying lands, and involves needless expense.

Field water capacity tests have been made in Oregon in connection with irrigation investigations for the leading soil types in the chief irrigated sections of the State. Duplicate tests are made, using sheet metal cylinders 1 foot long and 6 inches in diameter. These are forced into the moist soil their entire length and are then dug out, struck off flush at the bottom and covered with a perforated base. These cores are then saturated, drained to constant weight in the covered jars, and their water retaining capacity determined by oven drying samples of the core. Other moisture points, such as drought point and excess points, are determined by methods described elsewhere. (Powers, W. L.—Economical Use of Irrigation Water.—Ore. Exp. Sta. Bul. 140, 1916.) From these studies, a generalized chart has been prepared as a guide to irrigators

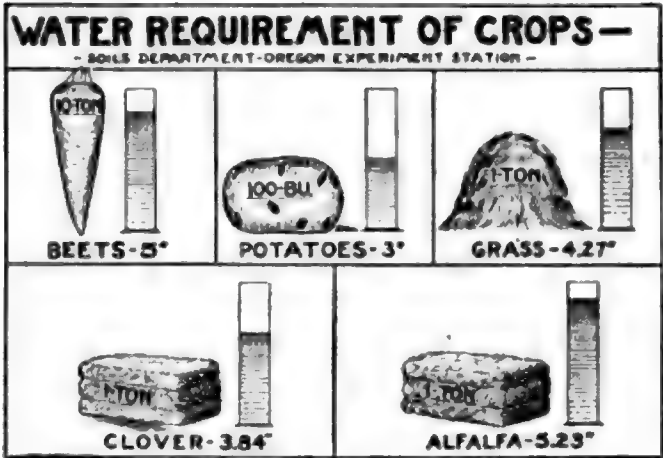


FIG. No. 2.

showing the usable water capacity of soil classes. It is shown as Fig. 1.

Modern irrigation contemplates that water be measured and applied in known quantities, according to usable capacity of the soil and extent of the root system of the crop. Then, to irrigate an acre of potatoes which have their feeding roots largely within the first three feet of soil, grown on a fine sandy soil, having usable water capacity of one acre inch to the foot, three acre-inches will be required, provided the soil is dried out to the drought point. Since a cubic foot per second will make an acre inch in an hour, it will require three hours with such a flow to irrigate the patch. The writer has been shown elsewhere (Powers, W. L.—Water Capacity and Drought Point of Soils.—In press. Current number of Soil Science) that the wilting point has an important bearing on the best time to irrigate to obtain highest yield and duty of water.

II. Value of Rotation and Manure. Rotation of crops costs little and is very profitable on all soils. It permits increasing the humus and nitrogen supply by the turning under of legume sod and manure and crop residues, thus increasing the water capacity, tilth and fertility. As a seven year average rotation at the Oregon Experiment Station has given an average yearly net profit under irrigation of \$14.09, while rotation and manure under irrigated conditions has increased the net profit an acre from beans by \$23.02. The detailed data is presented in Table No. 1. A three year rotation is used, namely: grain, clover, and beans. The yield per acre inch and net profit an acre inch are about doubled by the rotation and manure. The water

TABLE No. I.
VALUE OF ROTATION SEVEN YEAR
AVERAGE
(OREGON AGRICULTURAL COLLEGE EXPERIMENT
STATION—DEPARTMENT OF SOILS)

TREATMENT	Average Yearly Yield		Average Net Profit			Water Requirement (Lbs. per lb. Dry Matter)
	Bu.	Acre Inch	Acre	Grain from Rotation or Manure	Acre Inch	
BEANS Continuous	8.24	Bu.	\$11.55			2,909
Rotated	10.13		20.37	\$ 8.82		2,249
Rotated and Manured	12.91		21.68	9.71		1,900
Irrigated Continuous	9.85	3.82	15.37		\$ 5.12	2,622
Irrigated and Rotated	15.74	6.10	29.46	14.09	9.82	1,794
Irrigated, Rotated and Manured	18.29	7.14	38.39	23.02	12.80	1,425

requirement per pound of dry matter is reduced by these treatments nearly one-half. This water requirement is determined by sampling the soil at time of termination of loss of soil moisture and adding to the pounds of soil water lost, the pounds of rain and irrigation water. The dry matter in crop—determined from moisture tests of samples taken at time crops are weighed—makes possible this determination of ratio of water consumed to dry crop produced, which gives an exact technical measure of water duty.

III. Crop Producing Power of Water. The water requirement has been determined for about sixty crop plots each year for the past dozen years in connection with duty of water trials at the Oregon Station and most of the detailed data may be found in Sta. Bul. 161. By hand picking each year, the plat of each crop which gave the maximum net profit an acre and calculating the average water requirement of the best paying plat by years, the twelve year average water requirement for the most profitable irrigation with good modern methods of farming has been obtained. This figure is given in average inches for different crops Fig No. II.

It has taken 5.23 acre-inches to make a ton of dry alfalfa under good conditions as a twelve year average, and this represents the net duty of water for this crop. That is, the duty of water is not likely to be less than 15 to 18 inches in a three ton country or 30 inches to 36 inches in a section capable of producing 6 tons an acre a year. Potatoes similarly are not likely to be produced with less than three acre-inches per hundred bushels.

IV. Relation of Fertility to Water Requirement. As indicated in the last column of Table I, the fertility of the soil affects the amount of water required per pounds or per ton of dry crop produced. This was recognized and reported by the writer as early as 1912 and has been noted by others. Desiring more exact data on the matter, a tank experiment was arranged to determine the water requirement of oats grown on two soils with different fertilizer treatments. One soil of strong fertility gave

TABLE No. II.
RELATION OF FERTILITY TO WATER REQUIREMENTS

(Oregon Agricultural College Experiment Station—
Department of Soils.)

Oats on Deschutes Medium Sandy Loam Soil.

Treatment		Yield	Water Requirement (Lbs. water to One Lb. of dry crop.)
Fertilizer	Amount Per Acre		
	Pounds	Grams	Pounds
Untreated	0	16.2	2125
Sulfur	100	57.9	594
Potassium Chloride	160	37.5	1020
Tri-calcium phosphate	100	35.9	1034
Sodium nitrate	100	44.8	842
Sulfur	100		
Sodium nitrate	100	42.3	867
Sulfur	100	40.7	946
Potassium chloride	160		
Sulfur	100	29.2	1202
Tri-calcium phosphate	100		
Sodium nitrate	100		
Potassium chloride	160	58.5	650
Tri-calcium phosphate	100		
Untreated	0	15.0	2219
Manure	10 tons	76.3	390

moderate variations in water cost with the different treatments; the other a soil of medium fertility, gave a striking difference in yield and water requirement. See Table II.

Low water requirement and maximum net profits are important considerations in increasing duty of water. The irrigation requirement and water requirement will vary somewhat with the season and anything which affects the evaporation, percolation on transpiration of soil moisture will have an effect upon the irrigation requirement, anything, in fact, that contributes to good irrigation farming as planting, irrigating or cultivating at the right time tends toward economical use of irrigation water. Proper economical irrigation is necessary to permanent irrigation agriculture. It is fundamentally important in irrigation farming to practice a careful rotation of crops that will permit plowing in legume sod and crop residues every few years to keep up water capacity and fertility and lower the water requirement. If we can save 50 per cent of the water used in many places, we can practically double the crop producing area. Furthering the economical use of water will, therefore, help to establish highest productive values and add permanently to the food output and wealth producing area.



Look for this Blue and Gold Armco Label on Washing Machines, Stoves, Ranges, Refrigerators, Enamel Table Tops, and other household and commercial utilities. It carries with it the assurance of the quality and solid worth of the sheet metal parts of articles that bear it.

You would accept a certified check

WHEN you buy a stove, a washing machine, a refrigerator or other household article, and it is stamped with the maker's name *and in addition has the Armco triangle*, you know it is as good as a signed, certified check.

The Armco triangle appears only on articles of full value, of more than ordinary merit. Manufacturers couldn't afford to use "Armco" Ingot Iron in cheap articles.

This pure iron resists rust. Because of its especially prepared surface it takes a coat of enameling with a rich gloss that is beautiful in appearance, easy to keep clean, and which has no tendency to crack or chip. Galvanizing holds to "Armco" Ingot Iron—or it is more true to say that the galvanizing and the pure iron base become as one.

Whenever you buy a culvert or other article made of iron, be sure to specify goods bearing the Armco trade-mark. It is certifying our signature to the "check."

THE AMERICAN ROLLING MILL CO.
MIDDLETOWN, OHIO



UNRETOUCHED PHOTO OF THE PILLAR OF DELHI

Enduring—Because made of **PURE** Iron

For sixteen centuries the iron pillar at Delhi has looked down unchanged on changing civilizations.

Torrential rains and scorching Indian suns have failed to mar this age-old structure. The material is *pure* iron—the impurities hammered out laboriously, minute quantities at a time, by the ancient Hindus.

The modern counterpart of this ancient iron is Armco Ingot Iron, possessing the same purity, and promising equal permanence. Already hundreds of

ARMCO CULVERTS

like the one pictured have been under our highways and railroads for a generation and show scarcely a sign of use.



A 60" Armco Ingot Iron Culvert, installed under a highway 15 years ago.



Ingot Iron

UNIVERSITY OF ILLINOIS
JUL 3

The HIGHWAY² MAGAZINE

JULY
1922

***Write to the nearest manufacturers for particulars
and prices on ARMCO (American
Ingot) Iron Culverts***

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Calgary, Vancouver, Vernon

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PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

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No. 6



Through the "Highway of the Giants" in Humboldt County, California. These Redwoods are from 300 to 350 feet in height and are estimated at from 3,000 to 7,000 years old. See article on page 12.



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The Importance of Tourist Traffic

THE summer season is now in full swing and thousands of people are going forth seeking beautiful scenery, cool woods and shimmering mountain lakes. Behind them, they will leave a golden trail of revenue for the localities they have to visit.

This fact was emphasized in a recent



Oakland Tribune

IT CAN'T BE DONE!

A cartoonist's idea of a tourist's dream.

statement by Willard M. Bryant, Field Secretary of the Michigan State Good Roads Association. Mr. Bryant stressed the importance of rushing to completion the good roads program as laid out in the state, saying that as soon as the main trunk lines are completed, the association plans to ask the legislature for an appropriation to be used in advertising Michigan as a summer resort country throughout the Middle West and the Mississippi Valley. It is believed that, if this plan were carried out in the right way, the people of the state would receive a yearly revenue of \$75,000,000 to \$100,000,000 from the resort trade.

Highways which open up vacation playgrounds to the motorist frequently run through sparsely settled territory, devoid of producing farms, and connect towns and villages which have no industries, so that it is difficult to convince the taxpayer of their value. However, the tendency seems to be to construct roads for the tourist even if they serve no other purpose as, for example, the road now being built by the State of Colorado to the summit of Mt. Evans. New York State, too, has set an example for its neighbors with a fine system of roads through the Adirondacks.

Australia Studies U. S. Roads

THE Australian government proposes to be careful in adopting a road-making program. D. V. Fleming, engineer of roads and bridges for South Australia, is in this country, studying types of roads. He was in San Francisco, and will visit the eastern centers. Mr. Fleming states that the road question is coming to the front in Australia because of the development of automobile traffic. There are very few hard-surfaced roads in Australia. There are some wood block roads which are very good, he states, due to a particularly hard wood used. In selecting the United States, Australia has picked the best school in the world to study roads in.

A Recent Discovery

Old fashioned virtues still bring substantial rewards. For instance, another man has been discovered who made his fortune by attending to his own business.

Four Good Reasons for Good Roads

By A. W. CAMPBELL, M. E. G. C.,

Commissioner of Highways for the Dominion of Canada.

GOOD roads are desirable for four distinct reasons, which may be called social, business, pleasure and national reasons.

The social reasons for general road improvements appeal more particularly to our country citizens. All farmers and their wives know better than any other class what bad roads mean to themselves and their families, particularly in the social aspects of rural life. In this respect, the conditions of the roads color their very existence. Farmers' locals, clubs and circles flourish when the weather and the roads are propitious. So, too, school and church attendances fluctuate as the road barometer reads "fine," or "muddy." Social amenities and community movements generally are promoted by good roads and the modern road vehicle; and the results are reflected usually in the tone of the centres served by improved roads, and in the evidences of public co-operation and mutual understanding.

The business reasons for improving the roads are still more numerous. The costs of hauling over the common roads depend upon the resistances offered by road surfaces and grades. If the surfaces are soft and yielding, the amount of tractive effort required of automotive vehicles,



A. W. CAMPBELL, M. E. G. C.

even on level ground, is relatively high. So, too, if the amount of rise on the road to be surmounted is much over 200 feet to a mile, the tractive force necessary, and consequently the costs of operation, are prohibitive. Crop correspondents of



The contrast in roads shown above typifies the contrast in social and economic standing of these respective communities. The roads are the barometers of civilization.

The Highway Magazine

the Dominion of Canada Department of Agriculture report that the reduction in the cost per ton per mile of hauling first over unimproved earth roads, and then over macadam roads, amounts to 12 cents. This is due, not alone to the increased pulling capacity of teams and therefore the sizes of loads, but also to longer hauling distance made possible by the improved type of road.

Any marketer knows that bad roads restrict the choice of both place and time of marketing. Many farmers have had to sell and also to buy in the closest market, knowing that they were pocketing losses on both transactions, because they were unable to take the time to make the longer haul.

Another economic effect of improved roads may be observed in the environs of any large town. The character of the agricultural activity usually changes, and the area of the change depends upon the condition of the various arterial roads leading into their hearts of business activity. Farming operations become more diversified, and the production of more high-priced, perishable food-stuffs, including milk and butter, for direct consumption, becomes more popular. Much fruit and wagon loads of potatoes and vegetables have simply gone to rot, when demand for these products was general, because the roads were too bad to warrant producers in taking the time and trouble to transport them to market. Good roads, therefore, tend very strongly toward widening areas of supply and distribution, the stabilizing of current prices and toward reduction in living costs.

THE PLEASURE FACTOR

The economic phases of improved road conditions are usually reflected in higher prices asked and received for farm property in the localities served by hard surfaces and low grades on the common avenues of their business travel.

As sources of enjoyment, improved roads permit the townsman as well as the countryman to receive splendid returns for the necessary investment. The smiles that break out and recur on the faces of travellers over smooth, wide, dustless stretches of highways, as fresh

scenes unroll to the vision, should be partial payments to financially harassed road committees. In fact, when count is taken of the immense sums paid out annually by townspeople, particularly for "movies" and other sources of temporary pleasure, it does appear that large expenditures are justified in building improved highways, for the single benefit from pleasure-riding to all citizens.

GROWTH OF AUTO INDUSTRY

The establishment of a new industry may be regarded as a general or national benefit. There are, for example, at least two industries of recent development in Canada, the success of which depends upon the improved conditions of our roads. These are: The automotive production and sales industry and the tourist industry. The former has, as a matter of fact, many dependent industries supplying parts in manufacture, accessories and in the repair of motor vehicles.

In 1920, the value of the products of Canadian manufacturers of automobiles, supplies and repairs amounted to \$137,420,351, produced in 2,503 establishments, 40 per cent of which are in Ontario. The capital invested in automobile manufacturing plants in Ontario, numbering 15, amounted in 1920 to \$53,597,244. Two more in Quebec increase the total of such investment in Canada to \$53,966,506. The wages paid to employees of these establishments in that year were \$10,688,657. The capital invested in automobile repair establishments, totalling \$19,943,913, is pretty generally distributed as between the different Provinces, averaging over \$2,000,000 for five Provinces other than Ontario. The phenomenal growth of labor and capital required to supply the demands of Canadians for automotive equipment is, in part, due to the forward-looking policy of authorities controlling the development of road systems, in the different Provinces. If each running motor vehicle is rated as worth \$1,000, the investment in rolling stock of this character in Canada amounts to \$460,000,000. And yet, unfortunately, our annual investment in improving the roads, over which this rolling stock is waiting to pass, is but a small fraction of this amount.

A Simple Method of Planning and Supervising Construction

By G. F. S. MANN,
Authority on Highway Construction.

In order to attain the greatest speed with a maximum amount of efficiency, organization of working forces and materials is absolutely essential to the contractor. Here is a tried plan to put in your note book.



The results of organization and correct methods of construction. A section of the famous "Apple Way" near Spokane.

IN all construction work success depends as much upon the executive ability of the superintendent as upon his technical knowledge. Before any men or materials are moved to the scene of operations, the following points should receive most careful attention by the contractor who has undertaken to perform the work.

The ideal to be aimed at is that when the work has been commenced it should be carried through to completion without any stops or delays. In order to accomplish this, the planning may be arranged in groups as follows:

- (1) The preparation of an accurate estimate of the materials required.
- (2) Arrangements for transporting the materials to the points where they are required at the proper time.
- (3) The preparation of a program of the order in which the work shall be carried out.
- (4) An estimate of the labor required for each part of the work.
- (5) A review of the operation in order to forestall any difficulties which may arise when the work is in hand.

Group No. 1 may be easily calculated by any of the well-known methods of making estimates, with the exception of

the use of empirical formulae in making up tables of quantities. Empirical formulae should only be used when the contractor has compiled a very extensive series of figures which are the results of actual observation on several contracts already performed, and even when



The time-keeper and the pay-master are important units in every well organized construction project.



Transportation of materials to points required on the road is of vital necessity to uninterrupted construction. In culvert installation, lightness plays an important part. Photograph shows Armco culverts being transported by mule team to a Federal Aid project in Smiley Canyon, Sioux County, Nebraska.

these old figures are available it is very much safer to make up an entirely new estimate from the plans and then use the old figures as a means of checking the new estimate.

In Group No. 2 it will be seen that two distinct points are taken up: first, the transporting of materials to the points where they are desired, and, second, the timing of the arrival of the materials so that they will arrive at the work only a very short time before they will be used. For example, in the case of a structural steel bridge it will be quite apparent that it is uneconomical to have the structural steel arrive on the job, any great length of time before the estimated date for the completion of the abutments and piers.

In the case of Group No. 3, if road building is taken for an example, it will be seen that it may be advantageous to finish some fraction of the work in entirety, say the first quarter, and so have the use of that part of the road while the remainder is being built, rather than to finish all the drainage structures first, and then do all the grading and finally all the surfacing.

In Group No. 4, an estimate of labor required for each part of the work can be made accurately only when it is based on careful time studies of the work done in previous contracts. If the contractor has had no previous experience in the kind of work required, he will find it well worth his time to make very careful time studies on the first work of that particular kind which he has undertaken to perform.

The laborers should be divided into gangs and the gangs allotted to specific tasks, the number of men in a gang depending on the task to which that particular gang is allotted.

In an emergency, men can work twelve hours at a stretch. If required for longer periods, they can work in alternate shifts of eight hours for two days. Beyond this time men can only work efficiently eight hours on and sixteen hours off.

The sequence of the several operations of the work having been settled, successful organization of the working party depends on the proper sub-division into gangs. Each gang will be composed of such mechanics and laborers as may be required for their portion of the work, and will be placed under a competent foreman, who is responsible to the superintendent in charge of the work for his gang.

By this arrangement the superintendent is able to exercise general control over the whole work, and make such deviations from the original plan as he deems fit to meet emergencies as they occur.

He is thus able, as in Group 5, to forestall any great or small difficulties which may be met with when the work is actually going ahead.

Utah Is Busy

THE State of Utah recently awarded road construction contracts totaling about \$950,000.

Mountain-side Road Justifies Builder's Faith

Difficult Construction in Milner Pass, Colorado, Includes Highest Stretch of Straight Road in the United States.

AFTER three years' of service, the Fall River Road, which runs from Estes Park to Grand Lake, Colorado, through Milner Pass is today one of the finest pieces of mountain road construction to be found anywhere in the United States or Canada.

This road was constructed by R. W. McQueary, one of Colorado's pioneer highway builders, under the supervision of the Colorado Highway Department.

The two accompanying photographs and the illustration on the cover of this magazine were taken in Milner Pass during the construction of this now famous road. They show to some extent the engineering problems which were solved by Mr. McQueary and the engineers of the State Highway Department.

There are five and one-half miles of road from the top of the pass to the foot, with a drop of 3,000 feet, the grade averaging from six to nine per cent. A dry masonry retaining wall, from six to twenty feet in height, extends the entire length of Milner Pass.

One of the most difficult pieces of construction was met in the building of Horseshoe Turn, which is shown in the photograph reproduced below. It is interesting to note that this road includes what is said to be the highest stretch of straight roadway in the country



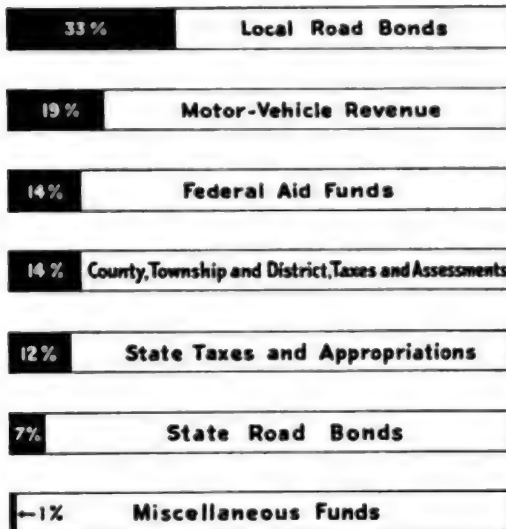
Photo shows the highest point of construction on the Fall River Road, 3,000 feet above the lake seen at the left. A dry masonry wall extends the entire length of Milner Pass. Construction on this wall had been started when the photo was taken.



The "Horseshoe Curve" on the Fall River Road in Milner Pass, Colorado.

Where the Road Money Comes From

We hear of millions being spent for highway improvement and construction, and perhaps we wonder from just what sources, from a national point of view, the money is secured. Here are some interesting facts and figures which tell the story.



A TOTAL of \$600,000,000 was spent for construction and maintenance of highways in the United States during 1921, according to figures compiled by the Bureau of Public Works, U. S. Department of Agriculture.

Where did this vast sum come from? Did every one of the 110,000,000 people in the United States contribute his share? Here is the answer.

A glance at the accompanying table will show that local road bond issues accounted for 33 per cent of the total. Motor vehicle revenue added 19 per cent more. The U. S. Government, under the Federal Aid Act, gave 14 per cent. County, township and district taxes and assessments secured an equal amount. State taxes and appropriations added 12 per cent, while state road bonds amounted to 7 per cent of the total. The last one per cent came from miscellaneous funds.

It is interesting to note the position of state road bonds in the table. A vast amount of publicity was given to the state bond issues, and yet they totaled only 7 per cent of the money spent in 1921. Local bond issues, on the other hand, contributed 33 per cent—almost one-third—of the \$600,000,000.

75,000,000 Dollars for Georgia Roads

GOOD roads enthusiasts in Georgia are boosting a campaign for a \$75,000,000 bond issue which will be used to construct 5,500 miles of a county-seat-to-county-seat State system of roads within the next ten years.

A leaflet entitled "Lift Georgia Out of the Mud", advocating the bond issue, which will be retired through the automobile and gasoline tax, carries the following statement: "With the Bond Issue, Georgia will be in a position to do in 10 years what it would be impossible to do in 30 years without the bonds. At no time during the life of the bonds, is there a period when there is not a balance for maintaining state roads."

Another piece of literature entitled "Georgia Good Roads Primer," put out by the Georgia Good Roads Association, takes up the problem and its solution in a well presented Question and Answer treatise.



Corrugated culverts of Armco ingot iron are used to drain this brick road near Moberly, Missouri. Here is a typical installation.

Organization for Road Maintenance

By GEORGE C. WHITE,
Senior Highway Engineer, Bureau of Public Roads.

In which the author points out the importance of a road maintenance program for counties as well as states, and gives some helpful suggestions.



This stretch of road on the Albert Pike Highway between Leonard and Stone Bluff, Okla., shows the advantage of an adequate system of maintenance. The hill on the right and the swamp on the left present a condition which requires adequate maintenance to keep this section in good repair.

ONE of the most important lessons we have learned from the good roads movement is that it is not only necessary to build good roads but that it is absolutely necessary to maintain them after they are built, and that practically all of our poor roads are the result of inadequate maintenance.

It is also evident that it will be practically impossible in the present generation to build roads fast enough to amply care for the developing traffic. It will, therefore, be seen that it is necessary that a great number of the present roads be maintained until such time as they can be rebuilt.

It is also evident that the best class of roads that can be built will rapidly deteriorate and eventually become impassable, unless given proper maintenance, but it has been shown that the poorest class of roads, if given the proper care and maintenance, can be kept in at least passable condition. This result can only be obtained through a well organized properly functioning maintenance organization.

It is not the object of this article to go into the details of maintenance, but rather to treat of the organization necessary for proper maintenance.

Up until the last few years the main-

tenance of roads, especially throughout the middle west, was in the hands of the county commissioners, or township trustees, and where there was any effort at maintenance it was in a hit or miss manner on certain roads of more or less local importance without any regard to the benefit other than locally. This system has proved costly and inefficient, all of the funds for maintenance having been expended, and very little, if any, good accomplished, and the people are demanding a better and more uniform system of maintenance. To accomplish this it is essential that each state have a centralized organization, with the authority and power to see that maintenance funds are properly and wisely expended so that the best results may be obtained.

In the last few years, a number of states have adopted what is known as the patrol system of road maintenance, and while this may not be the best possible system it has proved so much superior to systems heretofore in use that it is worthy of serious consideration.

There are various forms of organizations under the patrol system, but the one most generally adopted provides that the State Highway Department shall ap-

prove all maintenance programs and have general supervision of all work, otherwise it does not change the county form of providing funds and supervising maintenance. It is built up of patrolmen who either work directly for the county or take contracts to maintain a certain definite section of road. These patrolmen are under the supervision of an official of the county who has direct supervision and control of the road maintenance in that county, and works in conjunction with or under the authority of the State Highway Department through a maintenance engineer, or other official.

In preparing a maintenance program the county should, through the county commissioners, or otherwise, designate roads by classes of which at least three, seem to be necessary. The first class to comprise all state highways and roads of more than local importance, the second class to comprise county roads of local importance, and the third class to comprise roads that are only feeders to the other two classes, this program to be approved by the State Highway Department in order to insure continuity of maintenance on state highways.

The county commissioners should ascertain funds available for road maintenance, and each year, after deducting from the funds available, the amount of money which would be necessary for the rebuilding or replacement of bridges and drainage structures in the county, adopt a budget designating the amount of money to be expended on first class, second class and third class roads.

The funds so provided should be expended under the direction and supervision of the proper official. This official should receive reports for patrolmen of all work, and in turn report to county commissioners and State Highway Department of work performed and cost of same, and no bills for labor or material should be paid until approved by him and shown on his report.

• • • • •

Test for 12-Mile Oiled Road

ARRANGEMENTS have been made by the Engineering Experiment Station of the University of Illinois whereby a 12-mile experimental oiled road will be constructed this season.

The purpose of the tests is to determine, if possible, the relative merits of different kinds of road oils; the best method of applying the oil; the annual cost per mile of a well-maintained oiled road; and the number of days per year that an oiled road may be expected to be in good condition. The road chosen for the tests begins at a point about 2 miles northwest of Champaign on the Bloomington road, known as Five Points, and extends north a distance of 12 miles.

The experimental work will be under the supervision of Professors W. M. Wilson and C. C. Wiley, representing the Engineering Experiment Station of the university, and R. F. Fisher, County Superintendent of Champaign County.



A section of a Wisconsin highway under the Patrol Maintenance System. Wisconsin's famous Highway Patrol system was described in the June issue of *Highway Magazine*

Highway Hunches

Here is an idea which can be employed by patrolmen operating on hard-surfaced highways. It will win the motorist's praise.



The white marks on the highway pictured above will prevent broken springs and possibly more serious accidents, by warning the motorist of a bad depression in the pavement.

IT occasionally happens that a hard-surfaced road will break down because of the heaving of the soil, or the freezing of water in a crack, and cause a depression extending the entire width of the pavement.

The unsuspecting motorist may not notice this depression in time to prevent an accident to his car.

It is not always possible to immediately repair the road. A week or a month may elapse before the pavement can be more than temporarily mended. Until this hole is filled in and hard-surfaced, it is a constant menace to motorists.

In order to prevent damage to traffic, it is suggested that the patrolman include in his equipment an ordinary kalsomine brush and a small quantity of whitewash. White lines should be painted on the surface of the road 50 or 100 feet on either side of the break. This will serve to warn the motorist, particularly at night.

Where the surface of the road is white or light gray, a black line—using a mixture of lampblack, oil and turpentine—can be used with good effect.

Highway departments, using this warning marker, would, of course, instruct automobile clubs to inform their members as to the meaning of this danger signal.

WALLINGTON

Consult This Engineer

THE Editors are privileged to announce the appointment of Louis A. Graham, M. E., as Consulting Editor for *Highway Magazine*.

Mr. Graham, who holds the rank of Captain in the Corps of Engineers, U. S. Army, has had considerable experience in both the practical and editorial phases of engineering work. He will be happy to advise readers of *Highway Magazine* on highway engineering questions, as well as on questions pertaining to irrigation and drainage of land.

"The Highway of The Giants"

How the construction of a forest road caused the organization of a league to save the oldest living things in the world.

A LONG the western slope of the Coast Range in California stand the oldest trees in the world. Not only are they the oldest trees, but they are the oldest living things on earth—the Redwoods of California.

Bordering the California State Highway in Mendocino, Humboldt, and Del Norte counties, these giant trees, many of them estimated at from 3,000 to 7,000 years old, form a wonder archway for the tourist, travelling from Sausalito, in Marion County, to Eureka.

A queer situation has arisen in California as the result of building hard-surfaced roads, which is not altogether an unmixed blessing. With the coming of improved highways in the vicinity of the Redwoods, lumbering operations have grown enormously because the good roads made it possible to get out the giant logs by the use of the heavy motor truck.

Thus, we have a situation where good roads built through wonderful scenic forests are the very means of destroy-

ing the forests with their natural beauty and grandeur. To combat this wholesale deforestation of the finest forests in the world the "Save the Redwoods League" has been organized in California for several years, with very gratifying results.

Funds have been raised and several groves have been bought from lumbermen to save them from the axe. Agitation has been started for legislation that will provide an appropriation that will preserve the Redwoods, that border the State Highway for so many miles.

Public sentiment is coming more and more to the view that the true value of a highway lies not only in hard surface, adequate drainage and marking, but also in the natural scenic beauty and charm of environment.

Roads are pathways of pleasure and enjoyment, as well as economic arteries, and the preservation and conservation of beauty should be as highly considered as the problems of grading, surfacing, or drainage.



The devastation of the California Redwoods pictured above is the result of the misuse of good roads through the heart of the Redwoods Forest. The frontispiece this month shows a protected section of the "Highway of the Giants."



The Value of "Constructive Economy"

Those who have control of funds for public improvements should practice "Constructive Economy" by getting full value for every dollar spent.



Where water is worth its weight in gold. A fine example of "constructive economy" on a rich irrigation project.

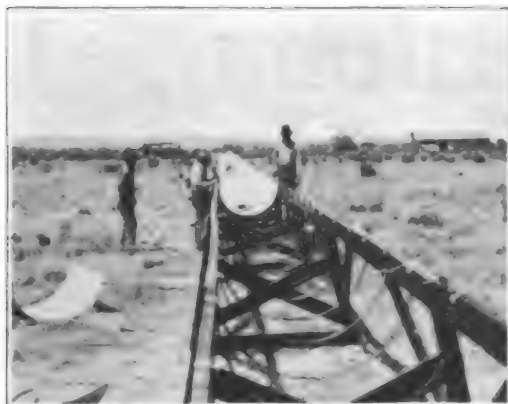
IT is often a question in the minds of many whether or not the majority of people who have to do with the expenditure of money have yet learned the real definition of "Constructive Economy."

There is no place where there is a bigger field for the practice of constructive economy than in the expenditures of public funds. In farming, mercantile business, banking or manufacturing, the man at the head of these organizations has his own money invested and when a dollar is spent, he knows it is his own dollar that is being spent. Consequently, he views the expenditures of every dollar from a constructive and economical standpoint and a man in his employ who writes the prescriptions for improvements or expansion of business that means the expenditure of money, is compelled to sit across the table from the gentleman with his own money in-

vested and defend, down to the last penny, the wisdom and economy of the expenditure proposed.

Unfortunately, this is oftentimes not true in the expenditure of municipal funds. One or more men are elected from a community and have the authority to spend the public funds. They are often good men with the very best of intentions, but not having their own money invested, and not as a rule being trained in constructive and economical expenditures, they do not and cannot get as much value out of a dollar as the business man that is trained along these lines and has his own money invested.

In a manufacturing plant, the engineer is the man called upon to write prescriptions for more economical production of the products and improvements. If he does not initiate such ideas and methods, he is called upon by the manager to find a method of devising new



Thirty-eight hundred feet of Armco flume being installed in the Burbank Irrigation District, Burbank, Washington.

equipment for more economically manufacturing some certain product. With his technically trained mind, he proceeds with his work. When he has his plans all recorded on paper he presents them to the manager and about the first questions the manager wants to know are, "How much will the new equipment cost? What will be the maintenance of operation? How long will it take it to pay for itself in the saving of manufacturing cost over the present method, and what would be the value of this new equipment after it had paid for itself in the saving in operation over the old method?" If the engineer is not able to answer all of these questions to the satisfaction of the manager, which is always based on economy in dollars and cents, his suggestions are not accepted. If the manager can be shown that it is a profitable investment, he accepts it.

This same method should be just as applicable in expenditures of municipal funds, but it is unfortunate that, in many cases, it is not. Some engineers, and especially some of the younger consulting engineers, seem to think that when they are engaged in a municipal project that their big capital is to show the municipality how small an amount of money can be spent in putting in a municipal water system, an irrigation system, or other forms of construction, without much regard to what the maintenance or up-keep expense is going to be and the service obtained from the construction.

It is not so much what the first cost

of an article is that should be considered, as what service it will give and what the maintenance or up-keep charges will be.

In many irrigation systems and municipal water systems engineers are specifying wooden flumes and pipe for carrying water, when a little investigation regarding the experience with wooden flumes in the older irrigating districts and municipal water systems that have been installed from 6 to 10 years would clearly show that the wooden type of flume or pipe for conveying water is only good from 6 to 12 years with an unusually big maintenance expense, generally beginning the second year of installation. In flume construction especially, there have been many annual breaks caused by leaks from the wooden flume undermining the concrete pillars that support the sub-structures.

YEARS OF SERVICE

Ten or twelve years ago in the older irrigation districts of Colorado, Utah and Southern Idaho, the irrigationists began the use of flumes made from galvanized metal. They found them much lighter in weight than wooden flumes, which made a big saving in the cost of transportation, required less material in the sub-structure and yet would carry water for hundreds of miles without a leak. Then, too, they also found that by giving the interior of these metal flumes a coating of a light asphaltic mixture about once every two years that it relieved the galvanized metal from the scouring caused by sand and silt in the water. They found that their maintenance on the metal flume was several hundred per cent less than on wooden flumes, and, while the metal flume might have cost them in the beginning from 25 to 33 1/3 per cent more than they could have installed a wooden flume for, yet experience has taught the irrigationists in the older irrigation districts that the metal flume in the long run was several hundred per cent more economical.

The fact that the U. S. Reclamation Service is using more metal flume in its construction work than any other flume material should be quite evident that they have found it the most economical in the long run.

Maintaining Water Level in Ponds and Lakes

How fluctuation in water level in artificial reservoirs can be prevented without the use of pumps, by employing automatic drainage gates.

NOT only is a constant water-level essential in irrigation projects, but it is usually desirable in artificial ponds and lakes where an expensive pump equipment is not feasible.

Where an artificial pond is desired for a breeding and hunting preserve for ducks or other game birds, or a swimming pool maintained without great expense, the best results are always secured if the water-level is not allowed to fluctuate.

Where a parent body of water is used to feed an artificial reservoir of this kind, a constant water-level may be maintained without the use of pumps or slide gates by the installation of a length of pipe in the feeder ditch equipped with a Calco automatic drainage gate on both ends of the pipe.

The Calco gates should be equipped with an eyebolt so that a chain can be attached to a light frame, as shown in the illustration, for raising and lowering the gate.

If it is desired to lower the level of the water in the reservoir the gate on the inside of the levee (on the end of the

pipe toward the reservoir) is kept open by means of the chain and lever, and the gate on the outside end is allowed to work automatically. In case a higher water-level is desired in the reservoir the operation is simply reversed, the gate on the outside end of the pipe being held open by the chain and frame attachment, while the inside gate is allowed to work automatically. Such an installation is practically an automatic pump, working without power or supervision.

There are many of these double-gate



Calco automatic drainage gate equipped with eyebolt and chain, as described in this article.



Photograph shows light frame construction adapted for use with Calco automatic drainage gates in maintaining constant water levels in ponds and lakes.



Thousands of feet of flume made of rust-resisting Armco ingot iron are in service in the irrigated regions of the West.

installations in various parts of the country giving satisfactory service, especially on irrigation projects in the West, on the rice plantations of the South, and in private game preserves.

To Improve Merced Irrigation District

WORK which it is estimated will cost in the neighborhood of \$10,000,000 is planned by the Merced Irrigation District, California. The work includes the construction of a concrete dam 310 feet high and 900 feet long. The dam will store 250,000 acre-feet. Construction of diversion intakes and tunnels and a power house of 45,000-hp. capacity is a part of this improvement. The estimates for the power house and dam construction amount to approximately \$6,000,000.

Other work planned by the district includes the construction of approximately 100 miles of canals and the installation of several large booster plants, estimated to cost \$2,000,000. To make it possible to build the dam and flood the Merced River canyon, it will be necessary to move the Yosemite Valley R. R. from Merced Falls to Detwiler. The estimated cost of this work is approximately \$2,000,000.

R. C. Starr, of Thebo, Starr & Anderson, consulting engineers, San Francisco, is chief engineer for the district.

•Advertisement•

'Bus Lines in Maryland

NINETY 'bus lines in Maryland have an average of 3 vehicles per line carrying an average of 16 passengers per vehicle that operate over an average distance of 19 miles per one way trip.



A typical installation of Armco flume. Note the construction of the masonry apron and the wooden framework.



General Hooker Used This Car in the Civil War

Yet in spite of its age and the unusual service to which it was subjected, it is still in use today. Usually railroad cars, made of ordinary steel or iron, rust out and are discarded in a comparatively short time, but there is a reason for the endurance of this historic car.

Originally it was made for the Nashville, Chattanooga and St. Louis Railroad. General Hooker made it his headquarters and General Mitchell used it as an ammunition car. General Sherman abandoned it at Kenesaw Mountain and soon afterwards the Confederate general, Hood, dumped it into the Etowah River. After the

war, it was fished out of the river, cleaned and put back in service.

A sample of the metal from this car was recently analyzed and was found to be old-fashioned iron. Chance was undoubtedly responsible for its exceptionally high degree of purity, while in ARMCO Ingot Iron, from which ARMCO Culverts are made, the purity of the metal is obtained by scientific and carefully regulated methods of manufacture.

When buying culverts for permanent installations, it is well to remember that "the purer the iron the longer it lasts."



The American Rolling Mill Company
MIDDLETOWN, OHIO



THE road surface above and the culvert below have widely different requirements. Rigid materials that make a satisfactory road surface will sometimes shatter under the stresses to which a culvert is often subject.

Rigid Above

The rigid road surface is favored by many engineers because it offers smooth travel to traffic, and resists the abrasive action of heavily loaded wheels.

Elastic Below

An elastic culvert construction is desirable in all cases, to withstand the great pressures that may be developed by shifting or hardening soils, or by the impact of traffic.

ARMCO CULVERTS

—because of the arch-like corrugated structure of the sheet metal, have the high elasticity necessary for reliable culvert service. With this they combine the indispensable quality of *purity* of metal, that makes them unique among all constructions in rust-resistance.

Fifteen years' service has proved that "Armco Culverts Endure."

The HIGHWAY MAGAZINE

UNIVERSITY OF ILLINOIS
AUG 3 1922

August
1922

**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
Ingot) Iron Culverts**

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Illinois, Springfield Illinois Corrugated Metal Co.	Ohio, Middletown The American Rolling Mill Co. The Ohio Corrugated Culvert Co.
Indiana, Crawfordsville The W. Q. O'Neill Co.	Oklahoma, Oklahoma City The Boardman Co.
Iowa, Des Moines Iowa Pure Iron Co.	Oregon, Portland Coast Culvert & Flume Co.
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Kansas, Topeka The Road Supply & Metal Co.	Tennessee, Nashville Tennessee Metal Culvert Co.
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Canada Ingot Iron Co., Ltd.

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The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIII.

AUGUST, 1922

No. 7



Section of Big Creek Road, cut through the solid granite along San Joaquin River Gorge. It was necessary to tie the men with ropes during the drilling of the ledge. A full description of this unusual construction will be found on page 3 of this magazine.



AUGUST, 1922

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Armco Culvert & Flume Manufacturers'
Association

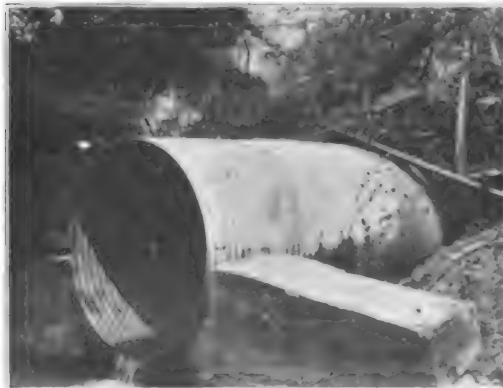
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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Labor Costs Low—Build Roads Now

LABOR costs on Federal Aid road building projects under construction this year, indicate that there will be no drawback along this line during the coming season, according to the Bureau of Public Roads. The price for common labor ranges around 25 to 30 cents an hour in the majority of states, being somewhat lower in the South and going up to nearly 50 cents on the Pacific Coast. The prices for teams were in a great many instances as low as the 1914 level, but it is likely there will be some increases in this line when the farming season begins, says the Bureau, as teams are always cheaper during the winter months.



Eleven years and still going strong! This 60-inch Armco culvert was installed in 1911 under a 20-foot fill. This highway will be concrete paved with Federal aid.

The Man of the Highway Survey

By JAMES EDWARD HUNGERFORD

For The Highway Magazine

With field-glass and transit and compass and rod,
With level and plumb-bob and chain;
With technical phrases,
And grit that amazes,
With hustle and muscle and brain;
You will find him a-pluggin' for all he is worth,
A-cutting an' slashing his way;
Anywhere 'neath the sun,
Where there's roads to be run—
This man of the highway survey.

His course leads through desert and jungle and swamp,
O'er mountain and river and vale;
From Havana to Nome,
And from China to Rome,
You'll find him at work on the trail;
And he cares not a rap what the hardships may be,
How rocky or thorny the way;
With his transit and bob,
He is right on the job—
This man of the highway survey!

He is laying out "tangents" and "curves" and "grades",
And marking each move with a stake;
And he's "snaking" his chain,
Over mountain and plain,
Through bramble and brier and brake;
Oh, his fights are not won with a saber and gun;
He follows no flag to the fray;
But he merits much praise,
For the part that he plays—
This man of the highway survey!



Foreign Interest in American Roads

FOREIGN countries, particularly those of South America, Japan, South China, Siam and Poland, are much interested in American methods of road construction.

In recent months the various state commissions have been visited by several Japanese and Chinese engineers sent to this country to study the operation of the federal and state highway organizations and to inspect actual construction.

The Romance of "Big Creek Road"

By CHARLES H. PEIRSON

Special Correspondent for THE HIGHWAY MAGAZINE

Cutting a highway through solid granite and maintaining communication by means of Alaskan dog teams, represents only part of the interesting features of building this mountain road.

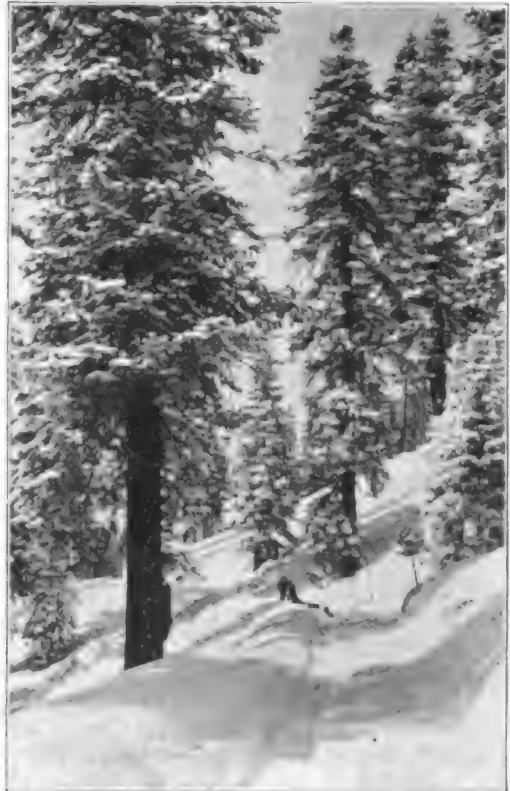
ROADS and Romance have always been associated in the minds of the poets. "The Open Road," "The Long Trail," "The Lure of the Road," all bring to mind the adventure and romance of "hitting the trail." The poets, however, have seemingly neglected the greater romance of the building of roads unless they hark back to the days of Caesar and The Appian Way.

Yet in 1922, in the newer lands of the world, Romance is not dead. From California comes a story that reads like a Jack London tale of the Klondike.

In attempting to carry on all-year-

round construction on a 14-mile tunnel under Kaiser Pass, high up in the fastnesses of the Sierra Nevada Mountains, the California Edison Company has met and overcome almost insurmountable difficulties.

Before construction on the tunnel that is to bring an additional water supply to Huntington Lake could begin, it was necessary to build a road from Cascada to Huntington Lake. This road is only five miles in length, yet there is a difference in elevation of 2,130 feet between its two terminals. Its construction affords the first adequate entrance into the Huntington Lake Country, and



Summer and winter scenes on the Big Creek road over Kaiser Pass. Elevation 9,300 feet. A dog team and driver can be seen in the background of the view at right.



"Mushing in from civilization." Alaskan dog team and driver taking in 500 pounds of mail and emergency supplies over Kaiser Pass in mid-winter.

it is the only road to Huntington Lodge. The maximum grade of this road is 17 per cent.

From the upper end of Huntington Lake to Florence Lake, about 16 miles of the necessary 22 miles covered by the Big Creek road have been completed. This road begins at an elevation of 7,100 feet, climbs to 9,300 at Kaiser Pass, and descends to about 7,500 feet, following the contour of the country to the upper end of the tunnel.

The tunnel which is being drilled through the solid granite underlying Kaiser Pass, will divert the waters of the upper San Joaquin River into Big Creek for use in a chain of power houses now being constructed along Big Creek and the lower San Joaquin River.

The section of road under construction along the San Joaquin River Gorge will connect Big Creek Power House No. 8 with Power House No. 3 and also the present road along the San Joaquin and Eastern Railroad between Auberry and

Basin. This part of the highway has presented some very difficult engineering problems, being cut out of the solid granite that lines the gorge. A good idea of the difficult nature of the work can be gained from the photograph reproduced on the frontispiece of this magazine, which shows the gorge and the construction crew working on an incline so steep that it is necessary to tie the men with ropes to prevent them from falling. The average cost of building this road is \$80,000 per mile.

One of the most unique features in the construction campaign is the use of an Alaskan dog team during the winter to maintain communication with the outside world.

The road over Kaiser Pass, with its elevation of 9,300 feet, is of course impassable to ordinary traffic during the winter. Due to the heavy snows and fierce mountain blizzards, it has been found impossible to maintain a telephone line, and therefore radio communication must be relied upon.

To afford means of winter transport in emergencies, and to regularly carry mail when the wagon road is impassable, the company brought a dog team and driver from Alaska. This outfit has completed its second season. The psychological effect on the considerable number of men in the remote camps has been found to fully justify the maintenance of the dog team.

Seven dogs are ordinarily used and the regular schedule is a one-way trip daily over the ten miles between Camps Nos. 60 and 61. In either direction this trip includes a climb of more than 2,000 feet to cross the high pass.

When snow conditions are favorable, the team can take a load of 500 to 600 pounds over this route. Although complete hospital equipment is maintained at the remote camp headquarters, a comfortable litter for the injured can be arranged on the sled.

This dog sledge is not used for carrying in ordinary camp supplies, these being taken in by trucks before the first snow flies.

When the Company's project is completed there will be a chain of six power houses which will utilize the water from Huntington Lake.



No soft ground on either side of this pavement.

NUMEROUS complaints have been received from motorists who travel brick and concrete roads, regarding the soft ground on either side of the pavement. They declare that this soft ground is dangerous, as drivers of cars, meeting one another at night, are apt to become confused, and, in their efforts to pass at a safe distance, may run off the pavement, where the soft ground causes the car to swerve, and possibly upset in the ditch. This condition is particularly dangerous after rains on newly-built roads where the

earth grade on each side of the concrete is particularly soft.

As a means of eliminating, or at least minimizing this danger, it is suggested that a small quantity of crushed stone be spread along on each side of the pavement. With this protection, the motorist would be able to get back on the pavement, in case he ran off accidentally, without danger of skidding into the ditch.

This, of course, would add to the construction cost, but it would certainly make narrow concrete and brick roads much safer for night travel.



Soft ground on the side of the hard-surfaced road presents a grave danger to motorists attempting to pass each other at night. Photo at left shows 12-inch rut made by automobile running off pavement. The car became mired in the ditch and had to be pulled out by teams. Photo at right shows an equally deep rut made by car which got safely back on the pavement after nearly capsizing.

The High Cost of Traffic "Cops"

The stupendous increase in the number of automobiles using the highways in the town and country, has resulted in the employment of a vast army of traffic regulators. Here are a few interesting side lights on the subject.



A member of the Women's Police Reserves of New York City, directing traffic during the milk strike last winter.

WITH the enormous increase in motor traffic in the past ten years the problem of traffic regulation, especially in the large cities, has become of increasing importance.

In many cities the number of police officers acting as "traffic cops" nearly equals the number whose sole duty is to prevent and suppress crime. Every year the city of Chicago spends a certain amount of time instructing school boys in the duties of traffic policemen, and at stated periods these youthful officers officiate as traffic cops in the less congested districts and near the schools which they attend, during the hours that the school children are on the streets going to and from school.

The increase in automobile accidents is the real reason for the necessity of the large number of policemen acting as traffic regulators. A recent check on the general run of auto accidents in California reveals the fact that the question of the "right of way" is the greatest menace to the safety of the motoring public. Out of 760 accidents checked

and recorded, 203 were found to be traceable to a violation of the "right of way" rule.

Other important causes of motor accidents are the cutting of corners and the cutting in ahead of another vehicle in a reckless manner.

Motorists are not always at fault. Careless pedestrians are the cause of many fatalities and it behooves those on foot to have an eye to their own safety as well as the safety of others. A traffic officer, no matter how vigilant, cannot prevent accidents if motorists and pedestrians do not observe the simplest rules of caution.

New York City now has a Women's Police Reserve which has done some fine work in directing traffic, particularly last winter when many of the women took the place of the regular traffic officers who were detailed to guard the drivers of milk wagons during the milk strike.



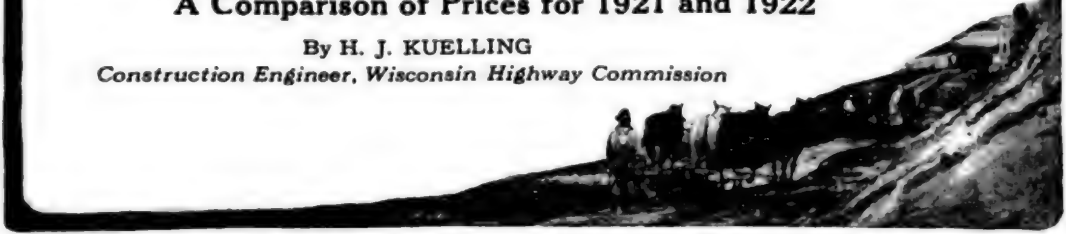
An innovation on the San Francisco police force. The large sun shades protect the traffic officers while on duty regulating traffic.

Why Wisconsin Road Costs Have Dropped

A Comparison of Prices for 1921 and 1922

By H. J. KUELLING

Construction Engineer, Wisconsin Highway Commission



THE Wisconsin Highway Commission has made a greater effort each year to have contract lettings early—at a time that the contractors would be relatively free from construction troubles. As very little paving construction can be done before April, the Commission aims to have most of its contracts let before that date. Partly because of this fact, only seven miles of paving construction, out of a total program of 354 miles, was carried over from 1921.

REVIEW OF 1921 WORK

This year the total program will reach about 450 miles of concrete paving, 400 miles of which was let by May 4th. This work is so divided among contractors that there is every reason to believe that last year's record can be duplicated and approximately 100% completion obtained.

As bids commenced to come in during January and February, it was evident that there was a very marked drop in prices. This became more noticeable in March and April; to such an extent, in fact, that what looked like a low price in the first two months became a comparatively high price later on. In other words, the early contractors began to congratulate themselves and some have even sub-let their work at quite a profit.

In order to get a fair comparison, the writer summarized the work let up to April 1st, 1921, and also in 1922. The work let up to April 1st, 1921, consisted of 56.89 miles of State-aid construction, and 32.32 miles of Federal-aid construction. The grading on the State-aid work consisted of 180,000 cubic yards or

3,180 cubic yards per mile, which cost \$1.23 per cubic yard. The grading on the Federal work consisted of 143,235 cubic yards, or 4,450 cubic yards per mile, which cost \$1.09 per cubic yard.

It will be noted that the grading on the Federal work is about 25% heavier, due probably to the fact that the Federal construction in Wisconsin is located by the state, while the State-aid is located by the counties. The State Department naturally placed the Federal work in the most difficult locations, and hence in the heaviest grading.

The grand total of the grading was 323,235 cubic yards in 88.91 miles, or 3,640 cubic yards per mile which cost an average of \$1.17 per cubic yard.

The surfacing in 1921 cost \$2.74 per square yard on the State-aid work, and \$2.84 per square yard on the Federal-aid work, or a grand average of \$2.77 per sq. yd. on the total mileage.

BIG DROP IN 1922

In 1922, up to April 1st, the grading consisted of 508,143 cu. yds. on 151 miles of pavement, or 3,360 cu. yds. per mile which cost 81c per cu. yd. It will be noted that this grading is slightly less per mile than that of a similar period in 1921. The surfacing in 1922 consisted of 1,598,512 sq. yds., which cost \$2.05 per sq. yd. on the average. From these figures it is readily seen that the 1922 paving is 72c per sq. yd. less than in 1921, while the grading is 36c per cu. yd. less than in 1921. Expressing these in percentages, we find that the paving is 26% less in cost than it was in 1921, while the grading is 31% less.

Making a comparison on a mile of road, we find as follows, (assuming

The Highway Magazine

3,500 cu. yds. of grading as a fair average of the two years):

Cost of a mile of 18-foot concrete in 1921:

10560 sq. yds. of paving @ \$2.77.....	\$29,251.20
3500 cu. yds. of grading @ \$1.17.....	4,095.00
Clearing, grubbing, culverts and guard rail	1,000.00

Total cost\$34,346.20

Cost of a mile of 18-foot concrete in 1922:

10560 sq. yds. of paving @ \$2.05.....	\$21,648.00
3500 cu. yds. of grading @ .81.....	2,835.00
Clearing, grubbing, culverts and guard rail	800.00

Total cost\$25,383.00

Thus it will be seen that the 1922 cost is \$8,963 per mile less than the 1921 cost, or, expressed in percentage, it is 26% less. Expressing it still another way: in 1922 we can build four miles of pavement for the same cost as three miles at 1921 prices.

This condition, and the fact that much of the 1922 work is bond issue work, means that 1922 is an ideal year to do road work at much lower construction cost, freedom from heavy immediate taxes, and with the advantage of caring for much unemployment.

With this situation obtaining, the Wisconsin Highway Commission encouraged counties with large bond issues to proceed with their work at an increased rate, but discouraged work that required direct taxes; in other words, advised action where the money was already raised. To add to, and encourage the situation, the premiums on road bonds began to rise until now quite a substantial premium is offered when a block of bonds is offered for sale.

The grading work in Wisconsin is quite variable, running from very light sandy soil to the heaviest clays, with some stone mixed in it; varying, in other words, from easy to difficult work. The work under comparison is a good average, some of all classes being included.

Included in the grading prices is the cost of building the earth shoulders, which will run from \$600 to \$800 per mile of road; in other words, the grading prices are from 20c to 25c a cu. yd. higher than they would be if the shouldering was let separately. Practically no elevating grader work is included, as Wisconsin conditions have not developed much of this type of work for several reasons; namely: the cross sections have been a little too narrow, the grade has been too rolling (meaning short cuts with waste of time in turning or going from cut to cut); too much stony ground; too light yardage. Most of the work has been done with wheelers, or frescoes, or with steam shovel and dump wagons; with some road grader work and some slip work from the ditches or on very short hauls.

The paving work included in the comparison is all of the standard Wisconsin type. It is all 18 feet in width, placed on a flat subgrade. It is 7 inches thick at the edge and 8 inches thick in the center, thus giving only a one-inch crown. It is all a one, two, four mixture, cured with earth covering. The mixing must be done on the road; that is, no central mixing plants will be permitted. The aggregates may be dumped on the subgrade or hauled in batches to the mixer. Materials, of course, must be up to specifications, the coarse aggregate



Tough going on a new Wisconsin road project. Grading in sections of this character means high cost per mile.



The price of unskilled labor is a big factor in the highway contractor's success.

being either gravel or crushed stone, and are kept clean after their arrival on the job.

Just why these reductions in prices were so marked is a little hard to explain. In fact there are many contributing causes. There is no doubt that 1921, at least in Wisconsin, was the most prosperous year contractors have known for a long time. Some contractors made a greater profit than for the past several years combined. This result came about because of a declining labor market, good railway shipping conditions, and an ideal year of weather. Needless to say, this news of profits became noised about with the result that many new contracting firms sprang into being over night as it were. With almost 100% of the 1921 contractors available; many new ones, and a considerable influx from neighboring states, competition was keener than ever before. It has not been uncommon to have from twenty to twenty-five bidders on a single paving job—a condition never existing before in Wisconsin.

Because of this very keen competition, the principal contractors crowded their sub-contractors such as graders, culvert bidders and truckers, to the very limit and also narrowed down their own margin of profit in order to get a job. This was especially true as the season wore on and the end of the lettings came in sight without their having a job. This crowding continued in some cases to such an extent that jobs were bid off at prices equal to or even less than the engineers figured was cost. This situation existed, not alone with new and inexperienced bidders, but with some of our oldest contractors.

Another condition that added to the competition was the comparative scarcity of paving work in some of the neighboring states, especially Iowa and Minnesota. As a result of this, many more than the normal number of out-of-state bidders came into Wisconsin.

Still another factor that added to the bidding was the large percentage of work in Wisconsin that does not require the shipping of aggregates. Of the 1922 program, about 60% will not require the use of railway equipment except for cement. About 100 miles will be constructed from special local pits and quarries and over 150 miles will be trucked from a commercial pit or quarry direct to the job. This factor, which is peculiar in Wisconsin, means that the contractors need not fear a shortage of gondolas later in the season, a condition which the coal strike may bring about. In the light of some past experiences, many contractors consider this a very important item, and bid accordingly to insure themselves one of the jobs that are independent of the railways.

On the one hand there is no doubt that prices of work let early in 1921 were out of line with the construction conditions that existed when the work was done, so that some of the reduction in prices in 1922 was warranted even if there was no change in conditions. On the other hand there is no doubt in the writer's mind that prices have been driven too low on some of the new work. Some contractors have been too optimistic and discounted conditions too much. Computing on a basis of 30c labor is too risky, for an increase is sure to come and it may even reach 50c for

common labor, while 40c may be common. Anticipating ideal weather conditions for 1922 is foolhardy, as last year was a year in a decade. A reasonably bad year, as to weather, can easily bankrupt many contractors, or at least put a large hole in their bank account.

Any reduction in freight rates will not help the contractors any because the contracts all state that any increase or decrease in the freight on material shall be added to or subtracted from the amount of the contract. In a similar manner, the cost of cement will have no bearing on the contractor's profit, as the cement is furnished in all cases free on board at destination to the contractor. All the contractor has to gamble with, in so far as cement is concerned, is to transport it and place it in the road, an item which runs from as low as ten cents to as high as forty cents per barrel.

COMMISSION ELIMINATES RISKS

It has been the aim of the Wisconsin Highway Commission in the past few years to eliminate as many variable items as possible from the contract, thus enabling the bidders to stabilize their prices. In other words, the Commission desires to assume as many of the risks as possible, such as variation in freight rates, changes in cement prices, etc. This is believed to be fair to both the contractor and the public who pay the bills, for, in the one case, it removes many elements of doubt from the contractor's mind and, in the other, the public only pays for what it actually receives.

The question of prices of sand, stone and gravel is still carried by the contractor and will continue to be so as the purchasing power of the contractor enters more in these items than in the others. There is no doubt that good contractors, with first-class credit, can purchase cheaper than the poorer grade

of contractors, and probably cheaper than could the state or counties. With cement purchases it is different, as the cement manufacturers are selling cement to the state cheaper than they will to a contractor or a smaller unit of government. In fact, the question of dealer's margin has been quite largely eliminated from the cement used in state highways.

SUMMARY OF CONDITIONS

The prices as existing at present are about the same as in 1919 when the average Wisconsin price was \$2.04 a square yard. Since then, of course, there has been a considerable increase in freight rates, which means the present prices are really lower than in 1919. In 1920 this unit price jumped to \$2.81 per square yard. In 1921 this dropped slightly to \$2.65 for an average of the entire year. The prices under comparison in this article are, in both years, for work let to April 1st. The writer does not believe that the percentages of reduction will hold for the entire years of 1921 and 1922. He believes this because the prices of work late in 1921 were lower than the earlier work, and further, because the work let in the latter part of this year will probably be higher than work let up to the present time.

With all these facts in view in making a comparison of 1922 and 1921 contract prices, the writer is of the opinion that very few contractors have jobs that are really as desirable as those of last year. In fact, it looks as if some have contracts that will require considerable efficiency, hard work, and good luck (especially as far as weather is concerned) in order to break even, let alone make a profit. There is no doubt that business conditions are moving upward quite rapidly and, with it, will go an increase in prices. A community which has already contracted its work is lucky, as work will cost more later on.



The Maintenance of Brick Pavements

By E. S. ALDERMAN

State Highway Engineer of Oklahoma

In this fourth article of a series contributed to The Highway Magazine the author discusses ways and means of maintaining brick roads.



A good example of a well-maintained brick road. Deteriorating joints can be effectively treated by flushing the surface with adhesive high grade asphalt and a thin coating of hot sand.

SUCCESSFUL brick pavement maintenance requires that proper attention be also given the sub-grade, shoulders, ditches, slopes and drainage structures, as previously described for the maintenance of other high-type wearing surfaces.

Good practice to date requires that for the greatest economy in the use of brick in roadways, the very best base be provided, and usually cement concrete is considered sufficient as offering the requisite rigidity of support, in order to permit the brick surface to retain for a maximum period the proper uniformity of surface.

If a cement-concrete base has been properly designed as regards thickness, mixture and properly constructed, little trouble may be expected from same. Defects in the base will be evident on the brick surface as soon as the faults occur. These may be remedied as explained in a previous exposition of the maintenance of cement-concrete pavements.*

A well built brick pavement will require less maintenance than any other type, except possibly, granite blocks. There are three standard types of brick pavement

construction: (1) a bituminous filled narrow-jointed brick surface, bedded on cement sand and supported by a cement-concrete foundation, (2) the same type of construction except that the joints are filled with a rich Portland cement grout and (3) the monolithic construction, the joints being filled of course, with cement grout. Three-inch vertical fibre brick is most commonly used. The base is seldom less than five inches thick of 1:3:6 mix, but these factors may be varied to suit the traffic conditions.

Old brick pavements in which the joints have been allowed to deteriorate may be effectively treated by thoroughly cleaning all loose material from the joints and the pavement surface, and when the surface is warm and dry, flushed with an adhesive, high-grade asphalt, absorbing the surplus with a liberal coating of hot sand or stone chips.

Where openings have been made in the surface to repair the base or for other purposes, the brick surfacing should be toothed back each way, leaving no bats or broken brick. The bedding course should be carefully turned and the new brick firmly and evenly bedded,

*See Highway Magazine for June, 1922.



Serious accidents and great expense and delays in repairing road may be caused by the lack of proper drainage. Prevention of mishaps of this kind and delays to traffic can be eliminated by providing adequate drainage structures when the road is built.

great care being taken that the edges of the patch exactly conform to the old pavement. The filler may then be placed and the patch barricaded until the concrete has attained sufficient strength for traffic.

Cracks occurring in the base will appear on the surface and should be filled with hot asphalt to prevent the entrance of moisture from the surface. Such cracks may not develop objectionable features for a long period if promptly treated in this manner.

Prohibit the use of lugs, spikes, cleats and other sharp projections on tractor and truck wheels. It is not just that a very few persons be permitted to ruin a utility belonging to the general public.

Use only first-class materials in all repairs.

• THE MONTH •

On the Cover This Month

THE cover design on Highway Magazine this month portrays a typical scene in the upper region of the Cascade Range as the highway approaches Snoqualmie Pass, the highest point in

the Cascade National Forest, Washington. This section of the country is a veritable tourists' paradise at this season of the year.



Armco culverts provide perfect drainage in any kind of soil, and keep the roads open to traffic.

Irrigation and Drainage

Better Service at Lower Cost

By T. J. PATTERSON

Special Correspondent for THE HIGHWAY MAGAZINE

How a Colorado Company Solved an Interesting Irrigation Problem.

A DEMAND for increased efficiency and the lowering of maintenance expense were the chief factors involved in the replacement of a wooden flume by a modern installation of 600 feet of 16 gauge, 60-inch Armco ingot iron pipe on the irrigation project known as Bijou Ditch No. 2 in Morgan County, Colorado.

For several years the Bijou Ditch Company had attempted to maintain a wooden flume for carrying water across the bed of Bijou Creek, with unsatisfactory results.

Like all wooden flume structures, there was a heavy leakage due to warping, shrinking and cracking. Not only was the quantity loss of water significant, but the constant seepage menaced the safety of the substructure because of erosion.

The expense of constant repairs and



A section of the 600-foot pipe line, made of 60-inch Armco ingot iron, carrying water across the bed of Bijou Creek.



Another view of 60-inch Armco ingot iron pipe which replaced an old wooden flume on Bijou Ditch No. 2, Morgan County, Colorado.

replacement of wooden parts necessary to the efficient operation of the project became greater each year until it was found necessary to rebuild the entire structure or install a new system.

Because of the ever increasing cost of lumber during the past few years, it was found that Armco ingot iron pipe could be installed with greater economy than a wooden flume similar to the old type, particularly when it became evident from past experience that another wooden flume would necessitate replacement in a few years. Consequently the Directors of the Company got together, and as a result, the old wooden flume was replaced with the modern Armco pipe line described above.

The installation has now been in service more than two years and a recent inspection showed that it was in perfect condition and giving 100 per cent satisfaction, as the troubles of the maintenance crew are at an end.

New Project Near San Diego

CONTRACT was awarded May 1 to Bent Brothers of Los Angeles for the construction of a dam on the San

Louis Rey River in San Diego County, Cal., which is to cost \$750,000 and which is the first step in a proposed \$6,000,000 power and irrigation project. The project is to be carried out by the San Diego County Water Co. which is allied with the Santa Fe Ry. Co. Two other dams on the San Dieguito River are proposed for later construction. The plan is to store water for domestic purposes in the city of San Diego, for the development of power and for the irrigation, ultimately, of about 50,000 acres of land.

Highways

Trees for California Highways

THE State Highway Commission of California has granted permission to the Chamber of Commerce of Willows, to plant 500 black walnut trees north along the west side of Sacramento Valley State highway. South of Willows 50 trees of different kinds will be planted to demonstrate alkali resistant qualities.

The Board of Supervisors of Yolo County have been granted permission to plant coast oak, black walnut and Lombardy poplar trees along the State highways in that county.



A fine type of flume construction, showing strength of substructure and flume equipped with waste gates. The flume is made of Armco ingot iron, and was installed by Twin Lakes Reservoir and Canal Company, at Ordway, Colorado.

Eliminating Seepage Loss in Irrigation Canals

Uncle Sam says losses of water from reservoirs, canals and unlined ditches amount to between 34 and 67 per cent of the total supply.



No loss from seepage here. Delivering 100 per cent of the water received at intake. Section of the Mocking Bird Flume of the Gage Canal Company, near Riverside, California.

UNCONTROLLED by the hand of man, water, like fire, is a terrible master. Man has always been faced with two problems in controlling water and making it his servant rather than his master—flood control and irrigation.

The annual loss of life and property due to floods each year is well known and constantly before the public eye because of the spectacular element, characteristic of floods.

The economic loss to the country, due to the lack of irrigation in the arid regions of the west, or to inadequate and wasteful methods of irrigation is far greater every year than the economic loss due to floods, yet the public seldom realizes this fact because the spectacular element is not present.

Aside from the economic loss resulting from the unproductiveness of fertile land, due to the absence of an adequate water supply, there is a great loss on irrigated lands because of wasteful methods of irrigation.

Every year some farmers see their half-grown crops fail utterly, because of the lack of a few inches of water at the

proper time. At the beginning of each season the reservoirs on many large irrigation projects impound sufficient water to amply irrigate the total acreage depending on them, for the entire growing season, yet year after year thousands of acres receive from a third to less than a half of the required water, with a resultant crop failure.

These facts are borne out by investigations carried on by engineers of the United States Reclamation Service who maintain that losses of water, through seepage from reservoirs, canals and unlined ditches, on several of the government irrigation works, in the Northwest, vary between 34 and 67 per cent of the entire supply.

All this enormous waste, except possibly the loss from reservoirs, which is the smallest item, is classed as preventable. The substitution of water-tight conduits for the present unlined or partially protected canals and ditches would in some cases nearly double the capacity of the system, and in all cases greatly reduce the maintenance expense.

Water is the very economic life of irrigated regions. It will, however, never

become the perfect servant of man for this purpose until man has fully realized the possibilities of its *complete* and effectual use.

The appended table taken from the "American Civil Engineer's Handbook," Mansfield Merriman, Editor-in-Chief, gives some authoritative and enlightening data on the seepage and evaporation losses in earth canals in second feet per mile for average conditions in various types of soil:

greatest irrigation constructionists in the country, and backed by the service record of thousands of successful installations, approve Armco ingot iron flume which delivers 100 per cent of the water received at the intake.

This type of flume is made absolutely water-tight by a process of securely clamping together by tension and compression of outside and inside members of sheet ends, and the joints are com-

Seepage and Evaporation Losses in Earth Canals in Second Feet per Mile for Average Conditions, taken from "American Civil Engineers' Handbook" Mansfield Merriman, Editor-in-Chief.

Wetted Perimeter of Canal Section in Feet	Clay	Clay Loam	Sandy Clay Loam	Sandy Loam	Fine Sand	Coarse Sandy Soil	Sandy Soil with Some Gravel	Very Gravelly Soil
5	.08	.12	.27	.38	.49	.61	.92	1.53
10	.15	.24	.55	.76	.98	1.22	1.83	3.06
15	.23	.37	.82	1.15	1.47	1.83	2.75	4.58
20	.31	.49	1.10	1.53	1.96	2.44	3.67	6.11
25	.38	.61	1.37	1.91	2.44	3.06	4.58	7.64
30	.46	.73	1.65	2.29	2.93	3.67	5.50	9.17
35	.53	.86	1.92	2.67	3.42	4.28	6.41	10.69
40	.61	.98	2.20	3.06	3.91	4.89	7.33	12.22
45	.69	1.10	2.47	3.44	4.40	5.50	8.25	13.75
50	.76	1.22	2.75	3.82	4.89	6.11	9.17	15.28
55	.84	1.34	3.02	4.20	5.38	6.72	10.08	16.81
60	.92	1.47	3.30	4.58	5.87	7.33	11.00	18.33
65	.99	1.59	3.57	4.97	6.36	7.94	11.92	19.86
70	1.07	1.71	3.85	5.35	6.84	8.56	12.83	21.39
75	1.15	1.83	4.12	5.73	7.33	9.17	13.75	22.92
80	1.22	1.96	4.40	6.11	7.82	9.78	14.67	24.44
85	1.30	2.08	4.67	6.49	8.31	10.39	15.58	25.97
90	1.37	2.20	4.95	6.87	8.80	11.00	16.50	27.50
95	1.45	2.32	5.22	7.26	9.29	11.61	17.42	29.03
100	1.53	2.44	5.50	7.64	9.78	12.22	18.33	30.56

Water diverted from a stream of moderate slope must often be conveyed parallel to the stream bed for a considerable distance over gravelly soil. Take for example a canal designed to convey 140 second feet at the practical velocity of 2.5 second feet per second and having the following proportions: Side slopes 2 to 1; depth of water 3.78 feet; breadth at bottom 7.56 feet; wetted perimeter 24.46 feet. By averaging values obtained from the above table of seepage losses it is found that seepage from such an installation would amount to 7.47 second feet per mile of canal, a volume of water greater than that delivered by a 10-inch centrifugal pump.

This great waste of water can be eliminated by lining the canals and ditches, or by installing flumes. Modern methods as practiced by many of the

pleted by a special elastic compound which fills all interstices.

Installing an Armco flume not only prevents seepage loss of valuable water, but also obviates the possibility of damage caused in adjacent property, such as waterlogging of soil, or the rise of alkali.

One Man Gives \$3,000,000 Road

DELAWARE is planning to build 60 miles of road this year, which will bring the total mileage of paved roads up to 270 miles. The State Highway Department has compiled figures showing that Senator duPont has spent more than \$3,000,000 for the boulevard which he gave to the state. This boulevard is over 100 miles in length and most of it is completed and already in use.



ARMCO



Culverts and Washing Machines

Did it ever occur to you that a washing machine has the same excuse for rusting that a culvert has? Both are subject to a succession of wet spells and dry spells and the alkali contained in soap and washing powders is duplicated by the alkali of the soil.

A number of leading washing machine manufacturers have adopted ARMCO Ingot Iron for the sheet metal parts of their machines, because its remarkable purity and evenness of texture make it highly rust resistant.

This fact should be significant to the highway engineer or constructor who wants rust-resisting culverts. May we send you the proof that ARMCO Ingot Iron *does* resist rust?



The American Rolling Mill Co.
Middletown, Ohio

Under Tons of Earth

Under railroads and highways, below deep fills of earth and stones

Armco Culverts

retain their original shape and give lasting service.

Each corrugation acts as a resilient arch and supplies the elasticity necessary to support great pressures.

ARMCO Ingot Iron is 99.84 per cent pure iron. Because of its great purity it resists corrosion and insures long life.

"ARMCO CULVERTS Endure"



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The HIGHWAY MAGAZINE

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September
1922

**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
Ingot) Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Calgary, Vancouver, Vernon

The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIII.

SEPTEMBER, 1922

No. 8



Photo Courtesy National Park-to-Park Highway Association

This was the condition of part of a four-mile stretch of road through the Idaho Panhandle, before it was properly drained and graveled.



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Armco Culvert & Flume Manufacturers'
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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

National Motorists Association Formed

THE National Motorists Association was officially launched by delegates from twenty-three states and the District of Columbia at the first annual meeting held in Chicago recently.

Immediate relief from the excessive traffic conditions in the cities and from



Secretary of Agriculture Henry C. Wallace is presented with a bouquet by the Associated Florists of America.

double taxes heaped on automobilists; working out of uniform traffic regulations; investigation of road building and better construction to meet the needs of transportation; elimination of dangerous grade crossings; a drive against automobile thefts, and establishment of a national service bureau especially for touring, were some of the high spots of the resolutions passed by the convention.

The officers of the association are as follows:

President, Judge Meals.

First vice-president, Richard H. Lee, Chicago.

Second vice-president, B. H. Hagerman, Kansas City, Mo.

Third vice-president, C. H. Verschoyle, Dallas, Texas.

Fourth vice-president, Eugene Stuart, Louisville, Ky.

Fifth vice-president, J. Borton Weeks, Philadelphia.

Treasurer, H. M. Lucius, Baltimore, Md.

Three-Year Federal Aid Program Approved

STATE highway officials and all others directly interested in highway construction seem to be pleased with the highway legislation which now has been approved by each house of congress. The fact that the conferees provided for a three-year program carrying \$50,000,000 annually, increased the maximum of federal contribution, and gave the secretary of agriculture the right to make contracts prior to the actual appropriation of next year's funds, more than offsets the reduction of \$15,000,000 in the appropriation for the next fiscal year.

Montana Has Good Road Map

THE Montana State Highway Department has completed a new state highway map which is the most complete and accurate road map of the state yet compiled. It is the plan of the department to have a small size printed in folder form for general distribution.

Making A "Road Day" Mean Permanent Highway Improvements

By CHARLES DETERDING

County Maintenance Engineer, Sacramento County, California.

How the residents of Carmichael Colony, Sacramento County, California, proved that "Where There's a Will, There's a Way."

THE road day held in Carmichael Colony last March was a decided success, and the results should be far reaching. It is an ideal example of what can be accomplished by co-operation between the County Engineering Department, the Farm Bureau, Improvement Club, Chamber of Commerce or whatever body represents local progressiveness.

This idea had its inception among the people of Carmichael Colony. They appointed a committee to see Supervisor John Russi, in whose district Carmichael Colony is located. Mr. Russi greeted the idea enthusiastically, assured the committee that he would give them every assistance and ordered the newly appointed County Engineer to work in conjunction with the committee.

DRAINAGE FIRST

The engineer went over the proposed plans of the committee, made a thorough study of the work and developed plans accordingly. In this locality drainage

is undoubtedly the most important problem in road construction. A detailed examination was made of the district with the object of determining the most economical and efficient sizes and locations of culverts. The drainage was considered from two viewpoints:

First: The removal of all water falling on the road as quickly as possible.

Second: The elimination of obstructions in the natural waterways which cause the accumulation of water in the low places. Where water stands for any length of time the subsoil becomes saturated and its power to sustain the traffic is very limited.

ORGANIZATION

From the result of this study the number and size of the culverts were determined, and the corrugated pipes were delivered at the designated points three days before the road day.

In the meantime the committee met to determine upon a general plan of procedure. The Colony was divided



Digging culvert trenches with a pair of horses during Carmichael Colony's Volunteer "Road Day."



Laborers, bankers, farmers, and even the Mayor, turned out to make Carmichael Colony's "Road Day" a success. Here they are installing one of the nineteen Armco culverts used in the work.

into districts. Each district had a captain who was instructed in the work to be done. As far as possible the men in each district consisted of the residents of that district. This was done in order to make the necessary travel as short as possible and also because residents would be more familiar than others with the bad places in their localities.

Saturday morning, March 25th, all reported to their respective captains, bringing with them such equipment as they believed would prove useful. Throughout the day they worked with a will in order that the roads in Carmichael Colony might be put in first class condition. At the end of the day their efforts had resulted in a most creditable showing. The success of this enterprise is the result of community spirit. When we consider that 43 men, 3 tractors, 1 truck, 8 two horse teams and 2 four horse teams, with all the necessary equipment, spent the day on the road, it is not surprising that the Carmichael Colony road day was such a success.

PRACTICAL RESULTS

The day's work resulted in the installation of 19 culverts, repair of one wooden bridge, 6 miles of grading and the filling in of 12 low places. No work was done on Marconi Avenue or Landis Avenue. These are to be improved by the county. Likewise the county will

do considerable work putting the finish on many of the roads that were worked by the volunteers. This is a fine example of efficient co-operation. At no place did the work of the residents and the County Engineering Department overlap or conflict.

It takes at least three weeks to plan a road day and get the culverts on the ground, so it is the desire of the County Engineer that next year a great many of the communities in the county begin to plan a road day early in the year. With all the details worked out by the first of March, the County Engineering Department can handle a road day every other day. This would allow one day to move our equipment from one community to the next.

SUPPLEMENTING WORK OF COUNTY

It must not be supposed that these road days would eliminate any of the work that would be done by the county forces. There are approximately 1,800 miles of road in Sacramento County to be maintained in at least a passable condition, if possible. To reach all of the bad places in this extensive road system is simply out of the question. If a few of the worst places could be repaired by the communities each year, the county doing the general grading, in a very few years the entire system would be in first class condition.

Sand-Clay Roads in the Making

By LELAND F. JAMES

Former Instructor Experimental Engineering and Mechanical Processes
at the U. S. Naval Academy, Annapolis.

This article is based on information secured through personal interviews with R. T. Brown, Chief Field Engineer, South Carolina Highway Department; R. G. Thomas, Engineer in charge of records, and Editor of the S. C. Highway Bulletin; Assistant Engineer Rice, South Carolina Highway Department; Road Supervisor W. J. Wise, of Calhoun County, S. C.

IN those sections of the country where sand and clay abounds in the natural soil, there has grown up a particular kind of earth road which is deserving of discussion because of the satisfactory results possible of attainment at a comparatively low cost of construction.

The idea upon which the sand-clay road as a standard type of construction is based, is not new. More than a generation ago it was known that the tractive resistance along a sandy road could be considerably diminished by adding a surface layer of clay. Especially was this true in dry weather when the pull through the sand ruts was at a maximum. Also, a surface coating of sand applied to a clay road served to keep the road in passable shape in wet weather by reducing the slip and rendering the road less likely to cut into deep ruts and mud holes. It took many years of experiment, however, to determine upon a satisfactory combination of sand and clay that would bond into a

good road body of sufficient stability to meet the demands of normal traffic in both wet and dry weather.

The theory of sand-clay road building appears to be simple enough when it is read out of a book. All that is required to be done is to mix and puddle sand and clay together on a prepared sub-grade in such proportions that there will be a sufficient amount—and no more—of sand to fill the “voids,” thereby insuring that moisture will not be absorbed into the completed road body; then to shape the road to a smooth surface that will shed water and keep the surface so shaped and smoothed until such time as the road becomes well hardened under traffic.

The main obstacle in the way of putting this apparently simple theory into practice, is the fact that in no two localities are the soil conditions likely to be the same. In one of the central counties of South Carolina where with minor exceptions the roads are all of the sand-clay type, the County Engineer



A fine type of sand-clay road in Lexington County, South Carolina, recently completed under Federal Aid project, now under State Highway system.

states that in order to save the added expense of long hauls he is compelled to handle four different grades of clay, and sand of varying degrees of fineness. Therefore, since the success of a sand-clay road depends so largely upon properly apportioning the two elements in the mixture, the solution of many problems must of necessity be left to the intelligence and experience of the road builder.

PREPARATION OF THE SUBGRADE

Whether it be decided to build on an old road bed or along a new route, the ground should be plowed or broken to such depth and width as is needed to aid in securing the proper grade and width as set forth in the plans and specifications. Teams or tractor may be used. In hard or sticky clay soil it may be necessary to use a special design of groundbreaker commonly known as a "clay roter."

Provision having been made for special drainage features and cross-road structures, the loosened soil should be moved from cuts to fills or cleared from the right of way with teams and wheel scrapers.

As far as practicable, the grade should be reduced to a minimum, and in no case should it exceed five per cent if it can be reasonably avoided. The importance of grade should not be underes-

timated; it is as essential to a good sand-clay road as it is to a concrete highway.

As to width, the road should be made wide enough to allow ample shoulder area along the sides. The minimum should be at least twenty-eight feet between outside ditch centers, this width permitting a twenty foot ribbon or road body of surfacing material with a four foot shoulder on each side. The amount and character of the traffic may demand a wider road than this. A properly-designed, forty-foot road costs but little more, and for the same traffic it is certainly easier to maintain.

SELECTING MATERIALS

Where the natural soil conditions are such as to recommend the sand-clay road as a type of cheap construction, borrow pits for surfacing material of sand or clay—or both, depending upon the nature of the soil in the subgrade—should be located conveniently near the proposed road.

If the surface is sandy it may be necessary to remove several feet of the soil in order to unearth clay of a suitable quality for the admixture. Samples of the subsoil at any desired depth should first be obtained by drilling small test holes. The length of haul should not exceed one thousand feet, preferably much less.

Red clay, medium coarse-grained, readily mixes with any grade of sharp, live sand into a bonded mass that gives good results. The proportions should be about 6 clay to 4 sand.

Equally good results have been obtained from a fine-grained sticky clay of the soapstone variety—locally designated as "blue mud"—when mixed with sand in the proportions of about 4 clay to 6 sand. The main objection to this clay seems to be that the additional work required to secure a thorough admixture of sand and clay involves an expense that may not be warranted by the possible superiority of the mixture.

The grade of sand best adapted for use with any kind of clay is hard and coarse grained—one in which each grain stands out separately as a miniature particle of gravel. Any grade of sharp, live sand is suitable.

When clay suitable for use in the sand-clay mixture is found as the natural



Mixing materials for sand-clay road on the roadbed. Clay was added to the sand in the subgrade and plowed and harrowed together with one operation.

soil in the prepared subgrade, it should be plowed to a depth of from four to eight inches and to a width equal to that of the proposed surfacing. It is preferable to use a tractor for this heavy work. The broken soil should then be harrowed until it is thoroughly pulverized, when it is ready for mixing. Sand should now be hauled in from previously designated locations and spread over the pulverized clay to a depth of from four to eight inches, this depth depending upon the quality of materials and the proportionate amount of sand that is to be held in the mixture. Hauling over deposited material should be avoided until the road is completed. The sand should be cleared of roots, sod and stone over two inches in diameter.

MIXING SAND ON CLAY BASE

On the same day that the sand is deposited the road should be twice plowed and harrowed. The first plowing should begin at the outer edge, turning the soil away from the center; the second plowing should begin in the center, turning the soil toward the center. After each plowing the road should be harrowed until the sand and clay is thoroughly mixed and pulverized. The first time the road is wet, it should again be harrowed until the mixture is puddled, after which it should be shaped to the required cross section.

When sand suitable for the mixture is found as the natural soil of the prepared subgrade, clay should be hauled in from the borrow pits or locations that have previously been designated and then spread evenly over the subgrade to a depth of from three to six inches, after which it should be thoroughly mixed with the sand in the subgrade, puddled, and shaped as heretofore described for "Mixing Sand on Clay Base."

MIXING SAND AND CLAY ON EARTH BASE

When neither sand nor clay suitable for use in the mixture is found as the natural soil of the prepared subgrade, clay should first be hauled in from the designated locations and evenly spread over the subgrade to a depth of from three to six inches, after which selected sand should be spread over the clay to such depth that the sand and clay will be properly apportioned in the mixture. The added materials should then be



Hard going through a pure sand road in Florida. Note the specially built wide tires necessary in this region.

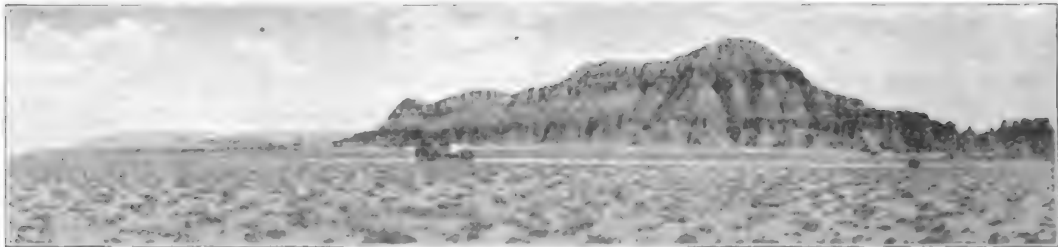
mixed, puddled, and shaped as heretofore described for "Mixing Sand on Clay Base."

SURFACE GRADE AND SIDE DITCHES

The cross section should be such that for a road body width of twenty feet there be a sand-clay thickness of ten inches at the center and four inches at the edges, measured from the subgrade level, thus providing a surface grade of 1 in 20, which is ample for shedding surface water.

On level ground and through cuts the surface grade of the road should be extended with an increased slope of about 1 in 12 over the shoulders to shape the bottom surface of the outside ditches. This work should be done at the same time the road body is being shaped. The shallow ditches thus formed take good care of the surface drainage.

A sand-clay road cannot be said to be "made" until it has been subjected to a properly ordered and well executed system of maintenance for a period of at least thirty days, or until such time as it becomes thoroughly compacted under traffic. It may be necessary to run over the road every day during this initial stage to keep it smooth and true to cross section, using a road machine or drag. Special attention should be given during wet weather to prevent the formation of ruts and holes. Undue neglect may result in the necessity of rebuilding the entire road structure.



Building a Road Through an Idaho Wilderness

By JAMES EDWARD HUNGERFORD
Special Correspondent for the Highway Magazine

THE recent completion of the first lap of the Clearwater Highway from Grangeville to Elk City, Idaho, is an event of far-reaching importance, for it opens a virgin area of five hundred thousand acres. In this area are included the great gold-bearing zones of central Idaho, together with large tracts of commercial timber on the Nez Perce national forest. The official estimates place the amount of virgin lumber in this forest at more than three billion feet, of which five hundred million feet will be accessible for removal through the construction of the highway.

In the early days, the old Nez Perce Indian trail to the buffalo country was the sole route of travel, and all freight from Wallula to Virginia City, Montana, and the placer mines of the Black Hills, was packed over it. Like all Indian trails, it traversed the high mountain peaks and summits, to avoid the deep canons on its route through Elk City, and crossed the Bitter Root Divide on to the Nez Perce fork of the Bitter Root Valley. Then, eastward, it penetrated the happy hunting grounds of the buffalo land, via the Deer Lodge Valley.

On this trail, Lloyd Magruder, a merchant of Elk City, and the independent Democratic candidate for Congress in 1864, who had packed into Virginia City, and was returning to his home with four other men, was brutally murdered and robbed, on October 11, 1873. One of the thrilling chapters of Idaho history is the account of the discovery of the murderer at his camp near Magruder

Mountain, and the final hanging by Lewiston vigilantes.

The historic trail was the only medium of travel from Grangeville to Elk City, until the last Territorial legislature made an appropriation to construct a wagon road from the present town of Clearwater to Elk City. This road, which follows closely the old trail, crosses two mountain ranges on excessive gradients, and traverses a heavily timbered country, which is wet and difficult to travel, except in the summer.

The new road will not only eliminate excessive grades and adverse conditions of soil and timber, but it will reduce the distance of sixty miles to forty-five. No other highway in the Northwest offers more scenic beauty, than this South Fork Route, but the new road has more utilitarian purposes in view. Besides the vast stretches of timber contiguous to the new highway, the new road traverses one of the greatest undeveloped mineral countries in the United States.

•••••

Montana Leads Mountain States

THE state of Montana leads all others in the intermountain group in the matter of federal aid projects completed, according to a report received recently from the bureau of public roads. Idaho takes second place in this respect, and Wyoming third. A total of 445.5 miles of federal aid projects had been completed by the state prior to March 31 of this year. Idaho has completed 410.1 miles and Wyoming 371.7 miles.

How Minnesota Spent Twenty Millions

The Details of Road Improvement Under the Babcock Plan

Facts and Figures by the Minnesota State Highway Department

MINNESOTA good roads work during 1921 spread lasting benefits on 3,393 miles of main highways and patrol and maintenance service on 6,855 miles of the 7,000-mile system of state trunk highways—all exclusive of betterments on the secondary or so-called farmer roads.

Paving built last year measured 109 miles, compared with 112 laid in previous years combined; and 765 miles of grading and 497 miles of gravel-surfacing were added to the respective 1,499 and 1,371 mile total listed as graded and gravelled when the state took over the trunk routes for improvement and perpetual upkeep. In addition, state maintenance forces re-shaped 1,137 miles and resurfaced 885 miles on the trunk system.

The Minnesota Highway Department last year planned and supervised projects representing an outlay of \$19,321,238.60, of which amount \$12,556,821.79 was used on the state trunk highways.

The foregoing are outstanding features of the 1921 highway review as announced by Charles M. Babcock, state highway commissioner. The record



CHARLES M. BABCOCK,
Minnesota State Highway Commissioner,
and originator of the successful Babcock
Plan.

mileages summarize Minnesota's banner year of good roads achievements.

John H. Mullen, deputy commissioner and chief highway engineer, stated that the figures are especially significant, inasmuch as the Babcock Plan was in actual operation only eight months of the year, having been put into effect on April 25. Although funds may be smaller this year, he added, the department with a more perfected working organization will strive to equal and even excel the initial year showing.

The 1921 state trunk highway fund of \$12,556,821.79 represented \$5,616,113.60 of motor vehicle tax revenue; \$2,840,000 of Federal highway aid, and \$4,100,708.19 of proceeds from county reimbursement bond sales.

The remaining \$6,764,416.01 used un-



Section of Minnesota's trunk highway near Fairbault. This is part of 150 miles of continuous pavement.

The Highway Magazine

der the direction of the State Highway Department was part of the fund of \$21,099,323 provided last year for local roads—other than trunk highways. The large sum for county-town road work was made up, according to the state auditor's abstract, of \$10,843,682 of county, \$6,862,660 of township and \$1,308,794 of small city and village road and bridge funds and of \$2,084,287 of state aid. With more than twice as much money provided for local road purposes as for trunk route betterments, Commissioner Babcock is moving to insure maximum benefits from expenditures on the secondary as well as the primary highways.

DIVIDING THE DOLLARS

Statistics gathered by the department shows that the average road dollar is made up of 63 cents of road and bridge tax funds, used on local roads, and 17 cents of motor vehicle taxes, 8 cents of federal aid and 12 cents of county reimbursement bond money—the three trunk fund sources of revenue. Regarding expenditure, 53 cents of the average trunk dollar went for new construction; 39 cents for maintenance; about $6\frac{3}{4}$ cents for equipment, and less than $1\frac{1}{4}$ cents for general administration expense.

Trunk system construction figures, compiled by O. L. Kipp, chief construction engineer, total \$10,342,594.28 of expenditures and many accomplishment items run into the millions. Construction outfits during the year moved 7,991,986 cubic yards of dirt and gravel

Of the average dollar used for new

construction on trunk routes, Mr. Kipp's report discloses, 40 cents went into permanent grades to make lasting foundations for highway surfacing that future traffic may demand; 17 cents into gravel surfacing; $26\frac{1}{2}$ cents into paving, and the remaining $16\frac{1}{2}$ cents for many miscellaneous items. The paving item carries an explanation in that about 18 per cent of the trunk highway construction fund was used for paving and that the 1921 paving mileage was abnormally high, due to the paving added by counties with reimbursement bond money.

Average mile costs of grading and gravelling run higher on state than on county work, and this is due, according to the official report, to the fact that trunk routes carry four times as much traffic as the county roads and must be of heavier construction. That the state department secured the lowest figures on 1921 work is shown, however, by paving contracts averaging \$1,200 a mile below the prices paid by counties.

DRAINAGE IMPROVEMENTS

To keep the grades drained and dry, 60,773 feet of portable culverts were installed, mainly at farm entrances, costing \$1.76 a foot, and 455 monolithic culverts at an average of \$705.73 each. Right-of-way clearing and grubbing, hand-ditching, special plowing, gutters and catch-basins, retaining walls and minor items are part of the new improvements.

The smoothing and other upkeep of 6,855 miles of trunk highways last season took \$2,224,227 of the \$3,000,000 fund



Building the road for permanence. Minnesota trunk highways are supplied with guard rails of various types. Surfacing and maintenance are the only items requiring future funds.



Uniform grades 30 feet wide, clean cuts and fills, good drainage and proper maintenance are the order under the Minnesota highway development program.

set aside for maintenance, according to W. F. Rosenwald, chief maintenance engineer.

Eighty-two cents of each maintenance dollar was paid for labor, the summary shows. Men and teams got 43 cents of the dollar or \$964,200, against a 28 cents or \$624,000 paid men and trucks. In addition, laborers took \$133,500—6 cents of each average dollar. Other items making up the dollar were about 7 cents for gravel, culverts and other materials; about 10 cents for equipment operation, and less than one cent for unclassified items.

Maintenance and special upkeep work on the trunk routes averaged \$324.46 a mile for the season. That includes wages of patrolmen—one for each 6-mile section—the reshaping and resurfacing operation which in some cases ran close to new construction figures, and other like outlays. Another maintenance dollar distribution shows 44½ cents to patrolmen; 28 cents for repairs; 21 cents for betterments; a little over 1½ cents for special work, and 5 cents for overhead expenses and superintendence of all kinds from executives to foremen. Shown in another way, smoothing and mending during the season cost \$144.70 a mile; repairs \$90.17 and betterments \$68.30; special work \$5.08 and overhead \$16.21 a mile.

EQUIPMENT AND INSPECTION

The highway equipment department, with shops at the state fair grounds and many fleets and smaller outfits in the field, was operated in 1921 at an over-all

expense of \$382,515.53, according to the report of R. M. Cooley, superintendent of equipment. A division of the average dollar spent for equipment shows that about 40 cents was used for new parts; 30 cents for new machines, and the remaining 30 cents for many small items. An appraisal of the surplus war equipment held here together with the accumulated earnings at going prices will show a big gain for the state when it is completed, Superintendent Cooley predicted, and preliminary figures show \$100,000 of net earnings.



On the Cover

THE wonderful scenery and remarkable engineering features encountered on the Yellowstone Trail are well illustrated by the cover design on *Highway Magazine* for this month, which shows a double hairpin turn the trail follows as it dips down from Snoqualmie Pass over the summit of the Cascade Range in Washington.



New Tests for Pittsburg Highway

ROAD builders throughout the country who followed with great interest the progress of the experiments on the test highway at Pittsburg, Cal., last winter, will be glad to know that the tests have been resumed. The experiments were discontinued on January 28 and since that time repairs have been made to the shattered sections to permit uninterrupted traffic.

Following the "Road to Health"

How hiking the highways for physical benefit is becoming increasingly popular.

WHEN all remedies and prescriptions fail to bring about any improvement in a patient's condition, doctors can always fall back upon the time-honored formula of "exercise and a change of scenery."

The days of cross-continent hikes which Weston, the master hiker, made famous, are coming back, as evidenced by the hundreds who are touring the world on foot. Many of these are seekers after health.

One of the most remarkable examples on record of an invalid walking to health, is that of William E. Jordan of Pasadena, California.

Jordan, a member of the A. E. F., in action in the Meuse-Argonne was severely wounded and gassed. He became blind and thirteen operations failed to restore his sight.

An accident brought back his vision. Rendered unconscious by falling against an iron cot, he opened his eyes to find that he could see perfectly.

Although he had been diagnosed as having tuberculosis and his weight had dropped from 160 to 95 pounds, yet he



Miss Pearl Cheifetz and Miss Lily B. Fenigston, after completing 1,000 miles of their cross continent walking tour.



Walking back to health. William E. Jordan, ex-service man and globe-trotter.

secured his discharge from the service and left the hospital.

He hiked from New York to Montreal and back in 25 days. His health improved to such an extent that he decided on a longer trip. On May 17, Jordan left New York City on a hike to California. He first stopped at Washington, D. C., and received a letter from President Harding to various executives along his route. The first sixty days out of the hospital he gained 55 pounds.

Two other advocates of the "road to health" method are Miss Pearl Cheifetz of New York City and Miss Lily B. Fenigston of Mount Vernon, who are on their way from New York to San Francisco. They expect to return to the East by the Southern route—a distance of 7,000 miles.

Whether you walk or motor, 'cycle or ride horseback, America's highways offer you the road to health.



Irrigation and Drainage

Oregon to Add Eleven Thousand Irrigated Acres

Tumalo District to be the Scene of Important Development

WITH the acceptance by the Tumalo Irrigation District of the bid of \$318,751.75 made by the United Contracting Company, work has been started which will result in the addition of 11,000 acres of irrigated land to Oregon's total.

The district to be developed is in Crook County, near Bend, on the Deschutes river, in the region known as Central Oregon.

Bonds issued by the district will be accepted in payment for the development work according to Secretary Wallace of the District.

While expenditure of only \$318,751.75 is indicated by the bid accepted, the total cost of the completion of the pro-

ject will amount to \$500,000, according to Mr. Wallace.

C. M. Redfield of Bend, Oregon, has been employed as district engineer and work is already under way and will be rushed to completion with all possible speed.

Five thousand acres of the 16,000 in the district are already under water. Irrigation of the remaining 11,000 acres was prevented by a leak in the storage reservoir from which it was originally intended to secure the water for irrigation.

The principal work to be undertaken by the United Contracting Company is the construction of a feed canal five and five-eighths miles long from a point just



The sinews of the war on aridity. Armco flume being installed on the Cascade Irrigation District, Ellensburg, Washington.



Armco flume on a large irrigation project in Wyoming. Absolute water-tight flume prevents undermining of sub-structure on installations of this character.

south of the county bridge within the Bend city limits and the building of a dam at that point. The Crescent Lake reservoir, recently purchased by the Tumalo district from the Walker Basin Irrigation Company, will be used for storage.

The superiority of Armco products is again illustrated by the fact that 12,250 feet of Armco Ingot Iron Flume will be used on this project.

Hetch Hetchy Near Power Utilization Stage

RAPID progress has been made during the past year on the Hetch Hetchy project which is to store waters of the Tuolumne River in the Sierra Nevada mountains, about 150 miles east of San Francisco, and bring to that city a supply of 400 m.g.d. An increase in the yield rate on the bonds so that they could be sold more readily, the settlement of labor troubles by putting tunnel work on the open shop basis, and the effective organization of the work have all contributed to better progress. It is

expected that water can be delivered by the end of 1923 through the 18.3-mile mountain-division tunnel. By that time the Moccasin Creek power plant, located at the lower end of the mountain division, and designed for a capacity of 70,000 hp. is to be ready for operation so that the water can immediately be utilized for power development.

The mountain division consists of a single conduit of full ultimate capacity. The portion of the aqueduct between Moccasin Creek and San Francisco, however, will be built in smaller units, probably three lines of pipe 7 feet in diameter, each with a capacity of 133 m.g.d. These will not be constructed until it becomes necessary to supplement the Spring Valley sources and this work should be deferred as long as prudence will permit, City Engineer O'Shaughnessy says, in order to minimize the financial burden. Meantime, the demand for power has made it worth while to rush that part of the work on which the first unit of power development depends so that revenue from the sale of power may aid in meeting interest on the investment already made.

Big Power Project in Puget Sound

By FRANK McKEAN

President and General Manager, Delta Electric and Water Company

Hydro-electric plant to serve the district with 40,000 horsepower is being constructed in Skagit County, Washington.

ONE of the most important development projects to be undertaken recently in the Puget Sound district is the erection of the auxiliary plant of the Delta Electric and Water Company, on Pilchuck Creek and Lake Cavanaugh in Skagit County, Washington.

The increase in population and the agricultural development of this section of Washington has made it necessary to provide greater facilities in the way of power for public utilities.

The company is building a hydro-electric plant of an ultimate development of 40,000 horse power. The main power plant when completed will operate under 750 foot head, utilizing an average flow of 550 second feet on a 60 per cent usage.

The first unit, to be located near the outlet of Lake Cavanaugh, will operate under 105 foot head, and will consist of a concrete arch dam 100 feet high and 700 feet long on its upper cord. The power house will be of con-



How the Delta Electric & Water Company's power plant on Pilchuck Creek and Lake Cavanaugh in Skagit County, Washington, will look upon completion. A 40,000 horsepower will be developed in this power project.



Carrying irrigation water over a dry arroyo in an Armco flume on the Rogue River Valley Canal Company's project at Medford, Oregon.

crete-steel construction, with red tile roof, and will contain sufficient space for two generator units.

The plant will be complete for the full 3,500 K. W. capacity except for the machinery, only 1,500 K. W. of which will be installed at first, the other unit being added later as the growth of the community demands.

The contract is being handled by Booker and Keihl of Seattle, Washington.

The Delta Electric and Water Company has a 25 year contract to furnish current wholesale to the interests supplying Fidelgo Island and Anacortes. Their 28-mile transmission line of 15,000 volts will serve approximately 1,000 rural customers resident in the Mount Vernon-Skagit River Delta District with light and power at very low rates.

The company recently secured a franchise from the Commissioners of Skagit County to build their lines along the roads of the county.

Conservancy Act for Flood Control at Pueblo

TO provide adequate protection against such destructive floods as occurred in 1921, the city of Pueblo, Colo., needed the legal right to organize a flood-control district which could issue bonds for the necessary work. To meet this emergency a conservancy act has

been passed by a special session of the state legislature. This law is modeled on that of the Miami Conservancy District in Ohio and as consulting engineer for flood-control work the city has retained Arthur E. Morgan, who planned and carried out the notable work of the Miami district.

Water Power Conference on the Southern Appalachian Region

A CONFERENCE to consider the general water power situation in the Southern Appalachian region and to consider its power needs and water power possibilities was held recently at Asheville, N. C. The meeting has been approved by the Secretary of War and the Secretary of the Interior. The engineers branch of the War Department, the Federal Power Commission and the Water Resources Division of the United States Geological Survey were also represented.

Among the more important subjects discussed were the location and possibility of development of large and small water powers and their relation to the market; the location and capacity of the water powers now developed; the relation of the larger power developments to each other and how they can supplement each other; what proportion of the power used in the Southern Appalachian States is developed by water and what by steam, etc.

Among those prominently identified with the work of the conference are: E. Lee Trinkle, Governor of Virginia, and Thos. L. Watson, State Geologist; Joseph Hyde Pratt, Director, North Carolina Geological and Economic Survey; Robt. A. Cooper, Governor of South Carolina; A. A. Taylor, Governor of Tennessee, and Wilbur A. Nelson, State Geologist; Thos. W. Hardwick, Governor of Georgia; S. W. McCallie, and Eugene A. Smith, State Geologists of Alabama.

Maryland to Spend Million and a Half

THE Maryland State Roads Commission plans to spend \$4,800,000 this year, \$3,000,000 for construction of improved highways and \$1,800,000 for maintenance of the existing system.

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The American Rolling Mill Company
MIDDLETOWN, OHIO

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PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIII.

OCTOBER, 1922

NO. 9



Photo Courtesy San Antonio Chamber of Commerce.

A very effective grade crossing warning sign on a railroad near San Antonio, Texas.
Even accidents of this kind may result in good if the lesson is not forgotten.



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Readers are urged to consult with Mr. Graham
on technical questions arising in connection
with highway and reclamation engineering.

U. of Michigan Offers Fellowships

THE "crying need" for good roads awarded not later than November 1, 1922, by the Board of Regents of the University of Michigan.

The Roy D. Chapin Fellowship in Highway Transport, which is offered to provide for the investigation of an approved subject relative to Highway Transport.

The Roy D. Chapin Fellowship in Highway Engineering, which is offered to provide for the investigation of an approved subject relative to hard surfaced roads and pavements.

General Conditions: Each Fellowship pays the sum of \$250 with an allowance of \$50 for expenses. The holders of these Fellowships do not have to pay tuition fees. A Fellow must hold a Bachelor's Degree from a college of recognized standing. He must enroll as a graduate student in highway engineering or highway transport and as a candidate for the degree of Master of Science or Master of Science in Engineering. He must be in residence for one of the following periods: First Semester (October to February); Winter Period (December to March); Second Semester (February to June). An application for a Fellowship must include a concise statement of the candidate's educational training and engineering experi-

ence, and three references. Applications and requests for information pertaining to the twenty-five advanced courses in Highway Engineering and Highway Transport offered by the Graduate School should be sent to Professor Arthur H. Blanchard, Engineering Building, University of Michigan, Ann Arbor, Michigan.

Kentucky Issues Road Magazine

THE "Crying Need" for good roads has found another voice in a new publication entitled, "Kentucky Road Builder." This publication is the official magazine of the Department of State Roads and Highways, and is edited by Joe S. Boggs, State Highway Engineer of Kentucky.

The purpose of the magazine is contained in the introductory editorial announcement which states in part:

"To acquaint you with the work and activities of the Department and to give expression in an official way to the movement of better roads in the State. The crying need of the hour is "good roads." It is heard from every section of the State and it is believed that this publication will bring about a concert of action on the part of those who are interested in better roads that will in the end result in Kentucky keeping in line with other States by furnishing the necessary finances for road construction."

Railway Bridge and Building Association Meets

THE Thirty-second Annual Convention of the American Railway Bridge and Building Association will be held at the Gibson Hotel, Cincinnati, Ohio, October 17 to 19, 1922. It is expected that at least 500 railway officers will be in attendance, due to the central location of the convention city, which has much to offer in attractions and climate.

Baltimore to Have Wider Streets

THE Board of Municipal Engineers, Baltimore, has adopted a standard for the width of streets, placing the minimum as 50 feet between building lines and 114 feet as the maximum.

Mississippi's Highway Patrol System

By J. M. McBEATH,

Chairman of the Mississippi State Highway Commission

How the taxpayer's money is being economically utilized to provide adequate maintenance of Federal Aid Highways.

PRESIDENT HARDING in his first message to Congress, said, "I know of nothing more shocking than the millions of public funds wasted in improving highways; wasted because there is no policy of maintenance. The neglect is not universal, but it is very near it. There is nothing that Congress can do more effectively to end this shocking waste, than condition all Federal aid on provisions for maintenance."

As a result of this message, Congress, in passing additional appropriation for Federal aid, safeguarded it with a drastic maintenance feature, which requires that all roads heretofore built, or to be built with Federal aid, must be maintained by the State Highway Department. If, after inspection the Federal Bureau finds that any Federal aid roads are not being properly maintained, the Federal government may give notice to the State Highway Department, and if the roads are not put under adequate maintenance within ninety days, the Secretary of Agriculture may have the work done and



J. M. McBEATH
Chairman, Miss. Highway Commission



A well maintained stretch of highway near Collinsville, Miss., built with Federal aid as projects number 106-101. The patrol system which has been inaugurated in Mississippi is described in the above article.

take the cost out of the State's allotment.

When it is necessary for the Secretary of Agriculture to maintain roads in this manner, no more Federal aid will be extended to the State, until the cost has been refunded to the Federal Bureau.

When the President caused the provision to be inserted in the law, he probably "builded better than he knew," for he could not have foreseen the wonderful effect on the roads of the United States by the maintenance requirements.

Until the convening of the last session of the Legislature, Mississippi had made no provision for State Maintenance, and in fact, the Highway Department was confronted with the Constitutional provision, which places; "All roads, ferries and bridges under the exclusive jurisdiction of the Board of Supervisors." The Legislature, however, submitted to the people of the State, to be voted on at the November election, an amendment to that section of the Constitution, which will make it read as follows:

"All roads, ferries and bridges shall be placed under the jurisdiction of the Boards of Supervisors, provided that certain roads shall be designated as State Highways, which highways shall be under the control of the State Highway Department for supervision and maintenance."

WHERE THE FUNDS COME FROM

Realizing that something must be done at once towards maintaining the Federal aid roads already built, the Legislature turned over to the State Highway Department, for that purpose, 50 per cent of the automobile tax, and 40 per cent of the one cent gasoline tax. But, on account of the constitutional provision giving the Boards of Supervisors full control over the roads, the Highway Department had to get authority from the Boards of Supervisors in the different counties before it could take over the roads. In most counties this was readily granted, and the Highway Department now has under maintenance approximately eight hundred miles of road.

After a committee of the Commission had visited several States, a system of maintenance patterned after that of Wisconsin was pronounced the most modern and adopted. This system, known as the

Highway Patrol System, provides that a man with a team and wagon, light grader and other road working machinery be placed in charge of ten miles of road to devote his entire time to keeping the road in perfect condition. This patrolman must report every day to the District Engineer, just the kind of work he is doing and where. This enables the District Engineer to keep a check upon the patrolmen and also on the condition of the road. While the Department has found it difficult to select dependable men in every instance, yet the system is working adequately, as the local people who pay the taxes are delighted and feel that the roads will not be worn out before the maturity of the bonds. As one farmer said, "It is the first time in the history of the State, that the taxpayers are really seeing their money come back to them."

IMPORTANCE OF SYSTEMATIC INSPECTION

Our patrolmen are being made to realize that one of the most important factors in maintenance is a definite and systematic method of inspection, by which slight defects are being discovered promptly as they develop and the necessary means taken to correct them.

Of course, the most important part of maintenance is the keeping of the roads in good condition, in order to take care of the traffic.

We realize that a proper maintenance policy is nothing more or less than a common-sense following of the old proverb, "A stitch in time saves nine."

The Federal Highway Act which was passed in 1917 and amended in 1919 and 1921, provides for a State Highway System to consist of 7 per cent of the total mileage. This will give Mississippi a State Highway System of some 5,000 miles, which will connect every county seat in the State, and it is proposed by the Amendment to put this system under the jurisdiction of the State Highway Department.

If the Constitutional Amendment carries at the November election, the State Highway Department will take over for maintenance, as soon as possible, not only all Federal aid roads, but all the roads known as the State Highway System.



Traffic Studies in a Tennessee County Reveal Interesting Facts

By N. W. DOUGHERTY

Professor of Civil Engineering, University of Tennessee.

Traffic data as to volume, weight and speed is essential in properly planning a road improvement program. Here is a tried method of obtaining this information.

DURING the summer of 1921, the Bureau of Public Roads, The University of Tennessee, The Tennessee Highway Department and Davidson County made a co-operative study of traffic in Davidson County, Tennessee. Counters were placed on the roads at thirty stations, and forty separate counts were made. An outline of the method of study and some of the results of the study have been published in The Engineering Experiment Station Bulletin of the University of Tennessee.

On two of the main pikes, a twenty-four hour count was made. The variation of traffic throughout the day is shown in the accompanying figure.

The total number of vehicles passing the stations in twenty-four hours was approximately 50 per cent more than passed the same stations in twelve hours, 6:00 a. m. to 6:00 p. m. The count was made in August. Toll roads in Williamson County showed that the traffic for

August was approximately 50 per cent higher than the average for the year. Thus, it is seen that the average daily twelve hour count in August is very close to the average daily twenty-four hour count for the year.

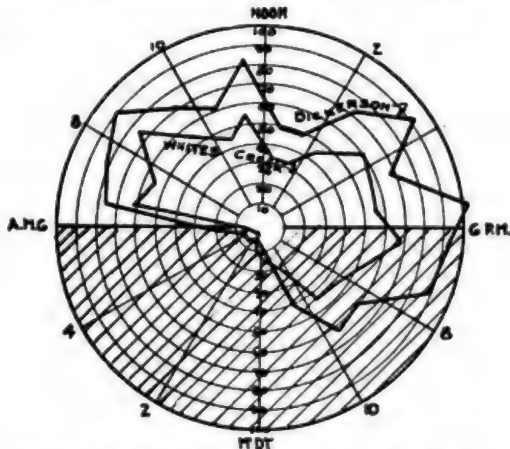


Diagram showing variation of traffic throughout a 24-hour period at two test stations in Tennessee.

On eleven of the main pikes a comparison of traffic was made for 1916 and 1921. It was found that the horse-drawn vehicles had dropped from 50 per cent of the total in 1916 to 16 per cent of the total in 1921, and on some of the pikes it had dropped to 5 per cent of the total. The motor-driven traffic had grown from 50 per cent

of the total in 1916 to 84 per cent in 1921. There was only a small decrease in the absolute number of horse-drawn vehicles, the decrease being 6.5 per cent. The motor traffic had, however, increased very greatly, the increase being 420 per cent.

A weighing station was established at the City Hay-Market scales. The most interesting part of the data taken was that relating to overloads. The follow-



Inadequate traffic data may spell the failure of a costly hard surfaced highway.

ing table gives the weights of a number of trucks passing over the scales:

Rated Capacity Tons	Gross Load Tons	Wt. on rear wheels	Load per in. width of tire	Tread of tire inches	Load
1½	5.81	4670	880	5¼	Flour
1½	5.00	4120	824	5	Hay
1	2.79	2240	895	2½	.....
Wagon	4.00	2760	1160	2¾	Lumber
2	5.71	4250	710	6	Cotton
3	8.3	6445	645	10	Brick
3½	8.24	6250	893	7	.....
3½	10.8	9550	1000	9¾	Brick
3½	8.35	6240	780	8	.....
7½	15.13	12950	925	14	Lumber

The great majority of trucks had a capacity of less than 4 tons. The tendency to overload, however, was not confined to any one size of truck. Wagons with steel tires also came into the running when overloading per inch width of tire was computed, the worst

offender being a wagon with 2¾ inch width tires having a load of 1,160 pounds per inch width.

Timing stations were established on a number of the roads. Contrary to general expectations, the average velocity of trucks was found to be 15 miles per hour and that of autos was found to be 21 miles per hour. In a few instances the drivers seemed to be in a great hurry and the expectations of the observers were realized. The careful drivers rarely exceeded 25 miles per hour.

Two methods of signaling were employed. Over short distances the stop watch and wig-wag signals were used. In some instances the driver, on seeing the signal and not knowing who was taking the information, would slow down, giving results that were too low to be average. To avoid this evil, observers were placed at inconspicuous places and given telephone connections and a stop watch. By this method the vehicle could be timed without the driver knowing it.

Properly taken traffic data as to volume, weight and speed is essential in intelligently planning an improvement program. Roads must be built to carry the traffic and the highway program should be so planned that the traffic costs will be reasonable. Excessive costs either from traffic in the mud or from expensive improvements should be avoided.



This can hardly be called a road. It is merely a place to build one after adequate traffic data has been secured.

Unique Drainage Method Saves Costly Road

How corrugated iron culverts, combined with timely action, preserved a costly pavement on a Fulton County, Georgia, road.

FULTON COUNTY, Georgia, of which Atlanta is the county seat, has hundreds of miles of beautiful roads, surfaced with various types of pavement. Some of the newest roads are concrete and recently concrete pavement was placed over a road on which the drainage structure had been built just a few years previous. Some of these drainage structures were of the non-metallic type, two of which recently showed signs of failure.

But for the installation of corrugated ingot iron culverts, one of these failures would have been disastrous to the pavement. This structure was over 100 feet long and was under a fill of approximately 20 feet. The non-metallic culvert gave way and let a large part of the fill drop, but fortunately remedial measures were applied before the pavement broke through. The part of the fill which had slid because of the break in the old culvert was cleared away and corrugated culverts, made of Armco ingot iron, in 20-foot lengths were pulled through the opening, one at a time. The pipe had been riveted up in a special manner so that the ends of the section were spiral for one corrugation. These spiral ends were screwed together as each length was pulled through, effecting permanent connection at the joints.

After the corrugated culverts had been pulled through the old culvert, the space between the corrugated culvert and the old culvert was filled with slush concrete, this concrete being poured through the catch-basins. The sketch on next page will illustrate how this was accomplished. This filled all the space between the two culverts, giving an even bearing on the corrugated pipe. This concrete, of course, filled up the catch basins until they could no longer function, and it was necessary to provide some other outlet for the water drained from the surface of the road itself. To accomplish this, another length of 15-inch corrugated iron culvert pipe was run from each catch basin down the side



Assembling corrugated iron culverts on concrete road in Fulton County, Georgia.



Showing the cut made in side of fill to take care of surface drainage.



Placing the 36-inch corrugated iron culvert sections inside the non-metallic pipe.



Showing the method of installing the 15-inch corrugated iron culverts to take care of surface drainage after old catch-basins had been filled with concrete.

of the fill and allowed to project over the head-wall, thus spilling the water from the catch basins directly into the stream—in one case above the culvert, in the other case below.

Had not material which combined great strength and elasticity with ease of installation, been ready at hand, the heavy fill would undoubtedly have gone from under the concrete pavement to such an extent that failure of the pavement would have resulted. This would have caused an expense of thousands of

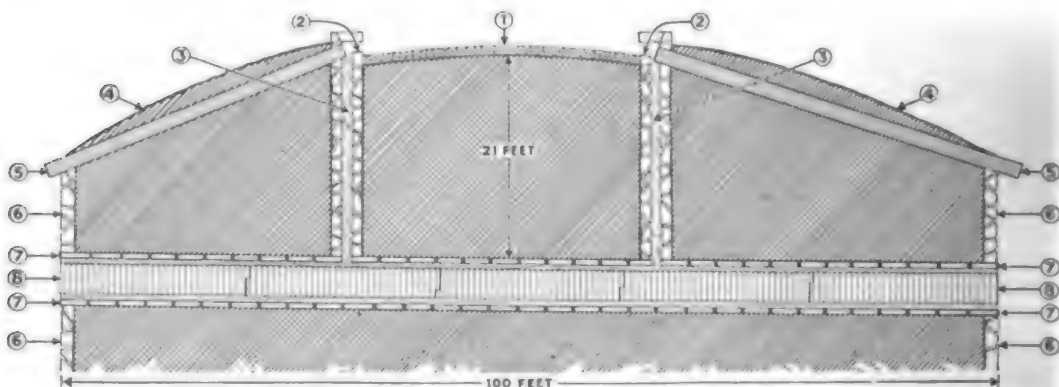
dollars for replacing the fill and re-paving the road the entire distance over which the failure would have occurred.

Corrugated culverts were not selected, however, purely because of their ease of installation and their strength and resiliency, but because it was felt that in installing them a permanent installation was being effected. This conclusion was reached after a special investigation of a number of corrugated culverts of large diameters which had been installed in Fulton County in considerable quantities previous to the year 1914. These old culverts are all in excellent condition, and practically speaking, in as good condition as the day they were installed. This factor of proved permanence assures an adequate drainage installation that will outlast the life of the pavement.

A study of the diagram below and the accompanying photographs shows every detail followed in this interesting drainage installation.



Showing the special manner of riveting corrugated iron pipe so that the ends of the sections were spiral for one corrugation.



Key to above diagram: (1) Concrete pavement over 21-foot fill. (2) Rubble masonry catch basins. (3) Slush concrete poured through catch basins to fill the spaces within the two culverts, giving an even bearing surface on the corrugated pipe. (4) Amount of side fill which was excavated and replaced in providing for surface drainage. (5) Fifteen inch corrugated pipe handling surface drainage after old catch basins had been filled with concrete. (6) Head wall. (7) Non-metallic culvert which failed. (8) One hundred feet of corrugated iron pipe installed in spiral sections within old culvert.

The Problem of the Pavement's Edge

By THE EDITOR

This is the first of a series of discussions by the Editor, as the result of a 3,000-mile motor trip through New York, Massachusetts, Rhode Island, Connecticut, Michigan, and Illinois.

CONTINUED observation throughout the western and central-western portion of the United States and certain parts of Canada has shown that far too little attention is being paid to the maintenance and even proper construction of hard-surfaced highways at the pavement's edge.

The pneumatic-tired motor vehicle is prone to pass off the pavement and on to the shoulder of the road where heavy traffic is encountered or when night driving is practiced. In spite of this, there is a noticeable lack of protection against this danger on the heavily-travelled roads in parts of Illinois and Michigan, for example. On the other hand, New York, Massachusetts, Rhode Island and Connecticut are noticeably progressive in this regard.

Where the pavement is not "finished off" at the edge with either bituminous or water-bound macadam, or sand-clay, there is a tendency toward undermining and breaking down. This is particularly noticeable where maintenance is neglected on bituminous-macadam surfaces.



Highway Magazine Photo.

Illustrating how the pavement's edge is maintained and protected by the New York State Highway Department.

A particularly striking break-down of the pavement's edge, apparently due to lack of maintenance, was noted on Michigan Trunk Line No. 11, a few miles east of Benton Harbor, Michigan. A close-up of this condition, which is a menace to traffic, is illustrated on this page.

The New York State Highway Department considers the protection of the pavement's edge very important. When a motor car runs off the hard surface its wheels encounter a smooth shoulder of bituminous or water-bound macadam on almost all of the main trunk lines. An accompanying photograph illustrates this feature.

In Massachusetts many of the main trunk lines are being noticeably maintained at the pavement's edge. In most instances crushed stone with a coating of bituminous material is being used. The gravel is dumped at intervals and



Highway Magazine Photo.

A striking break-down at the pavement's edge noted on Michigan State Trunk Line No. 11, as described on this page.



Highway Magazine Photo.
Showing the use of old railway ties to keep sand from shifting onto the road surface in the Cape Cod region of Massachusetts. The road is bituminous macadam.

then spread by hand. Then, in some instances, the binder is sprayed on by means of a motor-driven bituminous material distributor.

Protecting the pavement from shifting sand is also part of the work effectively carried on by the Massachusetts State Highway Department in the portions of the State where conditions make this type of maintenance necessary.

Two accompanying photographs show a stretch of road between Falmouth and Buzzard's Bay, Massachusetts. The highway is of bituminous-macadam, and, at the point pictured, cuts through a sand hill before under-passing a railway. Old railway ties have, as may be noted,

been placed on the sides of the cut to prevent the sand from shifting on to the surface of the road. These "sand breaks" are quite effective, but where several of the ties have been removed, the sand has pushed down to the edge of the pavement.

The highways in both Rhode Island and Connecticut are, in the main, adequately maintained at the pavement's edge. This maintenance makes the highway safer for motor-driven vehicles and also appears to preserve the hard surfacing.

On the Cover

THE cover design on this issue of *Highway Magazine* shows a stretch of concrete road that is a veritable invitation to the motorist to "step on the gas." This highway is part of the Illinois Federal Aid Project five miles north of Chillicothe. The photo is reproduced through the courtesy of the U. S. Bureau of Public Roads.

Forest Road Building Progress

EXPENDITURES totaling \$2,038,472 of national forest highway funds have been approved by Secretary of Agriculture Wallace for the construction of forest roads in California, Utah, Washington and Wyoming. This sum is distributed as follows: California, \$968,697; Utah, \$280,700; Washington, \$575,000; Wyoming, \$214,075. Wyoming will build the greatest mileage, 90 miles, California and Washington will build 50 miles each, and Utah will build 57 miles.



Highway Magazine Photo.

Another view of the road shown above, illustrating how sand shifted onto the road where the railway ties were removed, and stalled the Editor's car.

Gravel Road Construction and Maintenance

By GEORGE C. WHITE, Senior Highway Engineer,
United States Bureau of Public Roads, Oklahoma City, Oklahoma

The importance of building and properly maintaining lateral roads to connect state highways, is herewith discussed.

A NUMBER of counties and townships in Oklahoma are formulating road building programs that contemplate the building of lateral roads to connect outlying communities with the main roads of the State Highway System. In most cases, it is the idea to surface these lateral roads with gravel and it is the intention of this article to treat briefly of the construction and maintenance of gravel roads.

The first and most important question in building a road is the location, for unless a road is properly located the money expended in construction will be, to a certain extent, wasted, as a poorly located road can only be temporary, since the people traveling the road, as well as the trend of traffic and the movement of loads, will sooner or later force the road to the proper location. This statement is borne out by the fact that the railroads in numerous cases have abandoned old locations and at great expense have built on new locations in order to save time and money by reducing grades and distances; therefore the matter of location is of great importance.

The matter of grading and drainage structures will not be taken up at this time, as this article will be confined exclusively to gravel surface.

After the grading is completed the width and depth of gravel surface should be determined. This can be done by taking into consideration the traffic to be carried by the road which can be estimated from the number of vehicles and the greatest load of any one vehicle. It has been found, by experience, that a narrow gravel surface is not economical as it confines the traffic too closely and results in developing well defined ruts. These soon cut through and force the outside portion of the surface toward the shoulders, and build up the center of the road, causing a ridge. It is therefore seen that in no case should a gravel road be less than fourteen feet and preferably eighteen feet in width. It has been found most economical, from a maintenance standpoint, to have a wider surface with a slightly less thickness in gravel than a narrow surface with a heavy thickness, as it is comparatively easy to satisfactorily add more gravel to increase thickness but expensive and unsatisfactory to increase width.

After the width and thickness of the gravel has been determined, a grade should be prepared to receive surface material by cutting a regular section in the subgrade and throwing the dirt out on the shoulders. This section should



This narrow gravel road confines traffic within a small area, causing ruts and ridges.



Landing gravel from railroad cars at main gravel dump in preparation for 40 miles of gravel road construction.

be full width for the surfacing and should be from two-thirds to three-fourths of the depth of surfacing. After subgrade is prepared, gravel should be hauled in and dumped in the center of the road. Care should be taken to keep the dump in line and not allow gravel to be dumped promiscuously.

After gravel is dumped it should be spread either by hand or with a blade pulling from the center outward to the edge, being careful to take the center down a little below the desired finished surface as the gravel dumped in the center will be compacted more than that pulled toward the sides of the road.

The gravel should then be rolled or allowed to compact under traffic and bladed frequently from the edge toward the center. This will insure the thickness on the shoulders and edges and the loose gravel pulled to the center will insure the thickness in the center. This should be kept up until surface is thoroughly compacted and a uniform section obtained. After this, the surplus dirt pulled out from the grade should be bladed off and outward over the shoulders. The desired section of a graveled road is to have the surface as flat as possible and yet obtain the necessary drainage to take the water off the road.

The amount of crown necessary for this purpose cannot be given definitely as gravels vary in the amount of clay or binder which is the aggregate of a graveled road which makes them watertight.

After a graveled road is properly constructed it will need constant and close maintenance. Observation has taught us that many failures in gravel roads are started immediately after the construction of the same, and before they have been placed under proper maintenance.

The maintenance of graveled roads, as well as other types of roads, is a matter of prevention rather than a matter of cure.

Immediately after completion of a graveled road it should be constantly watched for the appearance of pot-holes and ridges. As soon as the gravel starts to disintegrate and shows that a pot-hole might develop, the disintegration and the surface immediately adjoining should be picked out until there is no sign of loose gravel or any material, this hole should then be immediately filled with new gravel containing binder and rolled or tamped solidly into place, adding water if necessary to cause it to bind. The place prepared should be left slightly higher than the adjoining surface to allow traffic to compact and bring to surface. After traffic has been over this place for awhile and it is still high it can be bladed or picked off to give the road a uniform surface.

The cause of the ridging of graveled roads is a question that has never been satisfactorily determined, but is probably due to inequality of the aggregates in gravel as they are affected by the traffic. Ridging can be minimized by a prompt action when it first appears. The action should be to scarify a little below the depth of ridges, binding smoothly and adding a little new material to the surface and compacting either by rolling or under traffic. If compacting is not done by rolling, the road should be watched carefully and dragged or bladed frequently.

From the above it will be seen that to obtain a uniform and serviceable gravel surface it will be necessary that the roads have proper maintenance, and unless funds are available and an organization perfected whereby this maintenance can be given to roads, then no matter how well a gravel road is constructed it will only be temporary. To achieve anything like the results desired it will be necessary to maintain and keep the road in repair after it is built.

Irrigation and Drainage

Defying the Rust Menace

Two California flume installations show fine record after twelve years of severe service, as described in the subjoined article.

THE final test of any manufactured product is service. After an engineer has inspected models, studied analyses, made laboratory tests, and satisfied himself from the standpoint of reason that the theory involved in any piece of machinery or material is sound, there is always one final question: "What will it do in the field under actual service conditions?"

In March, 1911, the Fresno Canal and Irrigation Company installed a double-barreled Armco ingot iron flume near Lillis, California. Part of this flume lies across a slough of the river, and during the heavy run-off in the spring this structure is entirely under water.

When the photographs on this page were taken the installation was partly submerged. The outside of the flume is



After 11 years of service this double-barreled Armco flume, installed by the Fresno Canal and Irrigation Company near Lillis, California, still shows a clean un-rusted surface.



Another view of the double-barreled Armco flume pictured above. Part of the year this flume is submerged, as shown in photograph. Although never cleaned nor painted this 11-year-old flume is ready for many more years of service.



Armco flume installed in 1911 by the Fresno Canal & Irrigation Co., near Laton, Calif. Although the wooden planks have rotted out, the flume is in first-class condition.



View of interior surface of Armco flume pictured above. This water has a high alkali content, yet there is no sign of rust on the flume. A faint water mark can be seen on the upper surface.

clean and shows no signs of rust. The hanger rods, which are of steel, are rusted. The flume is tight and does not leak.

In the photograph showing a close-up of the inside surface of the metal, a clear water line can be seen, yet there is no rust line or break.

After nearly 12 years of service this installation is in fine condition, although it has had absolutely no care. It has never been cleaned nor painted, yet it is ready for many more years of work under the same trying conditions.

In the same year (1911) the Fresno Canal and Irrigation Company installed 40 feet of Armco flume near Laton, California. Almost 12 years of service have left this flume in very good condition in spite of the fact that the water has a high alkali content and is very severe on metal. The hanger rods, which are of steel, are rusted and the wooden planks have rotted out.

This flume, like the one installed near Lillis, has had no care whatever, never having been cleaned or painted. It will be necessary to replace many of the timbers in a short time.

The fact that pure iron will resist rust has been proved by hundreds of actual tests under natural conditions of service. The engineer is interested in these tests because they offer evidence in support of claims, but the final proof comes in the record of service.

Practical Employment of Scale Models in Hydro-Electric Work

By WALTER GRAHAM,

Special Correspondent for *The Highway Magazine*

How the use of the following method resulted in a saving of 30,000 cubic yards of concrete in a single dam site.

WHEN a few pounds of plaster of paris, mixed with a still smaller quantity of highly concentrated gray matter, can be made to take the place of several hundred thousand dollars' worth of concrete, it may be said that some degree of efficiency is being displayed in the placing of materials.

In working out designs of dams and power houses, the firm of Thebo, Starr & Anderton, of San Francisco, are using a new method, which consists of making exact working models of the proposed construction. The photograph shown herewith is of an exact model of the Merced Irrigation District Dam, with penstocks and power house, showing its size related to a scale model of the old Call Building in San Francisco. The

scale of both models is 20 feet to the inch.

The dam shown in the photograph is 310 feet high above the river surface, and will therefore be the highest dam in America, so measured. It will be 830 feet long on the crest and 136 feet in thickness at the bottom. The design is a constant angle arch, with a spillway capacity of 60,000 second feet. From the dam there will be two penstocks 90 inches in diameter, approximately 1,500 feet in length, leading to a reinforced concrete power house 80 feet by 120 feet, in which will be installed two vertical reaction turbines directly connected to generators. The plant capacity is to be 44,000 H.P., under a 310 foot head.

This model was exhibited in the win-



This working model of the Merced Irrigation District Dam enabled the contractors to effect a saving of approximately 30,000 cubic yards of concrete in the final construction, as detailed in the above article.



Outlet end of Armco flume 480 feet long and 76.4 inches wide at top, installed in Merced County, California.

dow of McDonnell & Company, stock and bond brokers, San Francisco, during Shrine Week. It was viewed with great interest not only by engineers, but by thousands of business and financial men. The harnessing of mountain streams for power and irrigation is one of the romantic features of present day industrial development on the Pacific Coast.

These models have a very direct connection with the engineering work for hydro-electric and irrigation projects which is the specialty of Thebo, Starr & Anderton. Rex Starr, member of the firm, and now chief engineer of the Merced Irrigation District, explained in detail how by the use of plaster of paris models a saving of approximately 30,000 yards of concrete had been made at this dam site.

Actual differences in quantity of the plaster of paris models of the dam at the different points in the canyon are determined by displacement of the water by the models. The canyon walls, as shown in the picture, are made by building up the sides with boards one-half inch thick.

The upper and lower edges of each board therefore represent a ten foot contour, as the model is on a scale of 20 feet to the inch.

Drainage Survey by Aeroplane

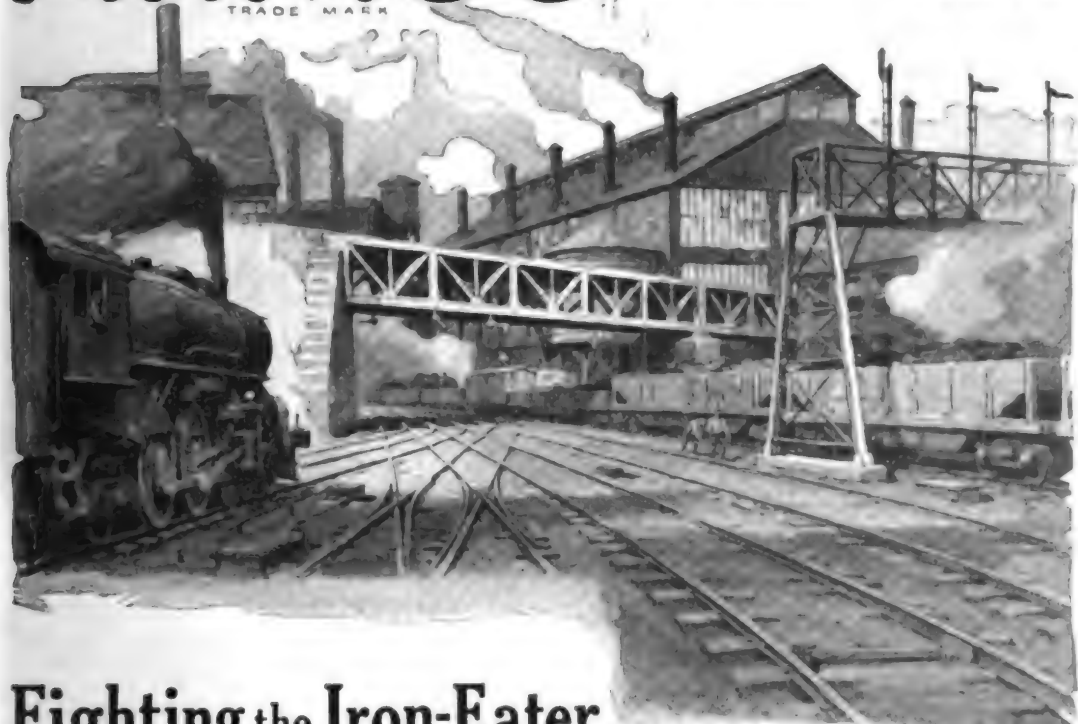
A SPECIAL reconnaissance has been undertaken for the Reclamation Service of the Department of the Interior of Canada in the vicinity of Le Pas and Cumberland House, lying on the boundary between Northern Manitoba and Saskatchewan. The survey covered the Carrot River triangle for a drainage scheme involving the reclaiming for productive purposes of from 200,000 to 900,000 acres. It had been found that a large part of the area was inaccessible owing to floods, reeds and willows which made canoeing impossible. The Air Board was accordingly requested to arrange a flight over the region, so that an engineer might secure the desired information from the air. Reports from the Victoria Beach (Manitoba) air station, which was the main base, indicate that the operation was a complete success.



To Push Study of Columbia Basin Project

THE Senate has passed a bill authorizing the Secretary of the Interior to investigate the Columbia Basin irrigation project in the State of Washington, a report to be made by Jan. 1, 1924. An appropriation of \$100,000 is provided for in the bill.

ARMCO TRADE MARK INGOT IRON



Fighting the Iron-Eater

ONE cannot think of a railroad without bringing to mind numerous forms of iron and steel essential to its operation, which in practically every instance are exposed to the elements.

To successfully combat rust, the great iron-eater, railroad engineers and executives have tried scores of expedients with varied success, but the one metal which has universally given satisfaction is ARMCO Ingot Iron. Its purity and homogeneity prevent the very action which causes rust.

ARMCO Culverts have been adopted by many of the leading railroad engineers because they resist the destructive action of rust and vibration. Highway Engineers can profit by the experience of their brothers who have been studying the problem for years. Write us for valuable data on conservation of metal.



The American Rolling Mill Company

MIDDLETOWN, OHIO



Seventeen centuries of storms and scorching Indian suns have left the Iron Pillar at Delhi, India, unscathed by rust. Analysis shows it to be made of almost pure iron.

The nails in this ancient Moorish doorway, made before the discovery of America, are still in perfect condition. Analysis shows a high degree of purity in the iron.

Samples of iron from this bridge, the first structural iron bridge in America, have proved to be almost entirely free from impurities.

The Confederate gunboat, Merrimack, was protected by an armor plate of pure iron. The plates were in excellent condition after a half century of immersion in salt water.

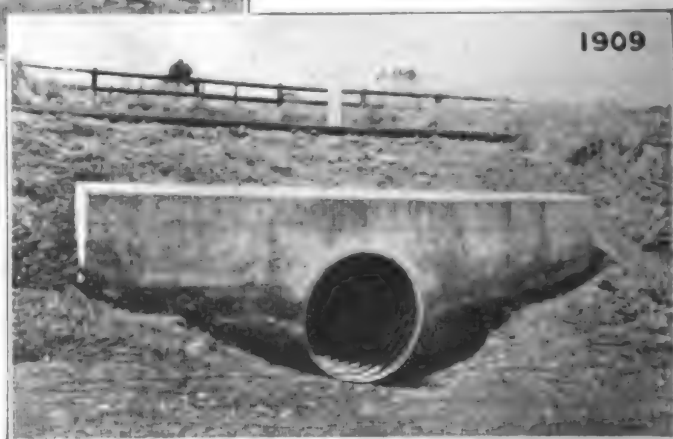


Down Through the Ages PURE IRON Has Endured

HISTORY has proved conclusively that the one factor that can give lasting quality to iron is PURITY. All of the specimens of old iron that have defied the ravages of time and come down to us in a good state of preservation have proved by analysis to be practically pure metal. Patterned in analysis after the old hand-forged iron, but produced by modern scientific methods, ARMCO Ingot Iron gives to

ARMCO CULVERTS

the one essential quality of rust resistance. Because of their basic purity of metal, their staunch construction, and the heavy coat of pure galvanizing which they receive, these culverts meet the most severe requirements of modern highway and railway work.



This 24-inch, 16-gauge ARMCO Ingot Iron Corrugated Culvert was installed in 1909 under the tracks of a prominent transcontinental railway. After 13 years of continuous service it is in a perfect state of preservation today.

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The HIGHWAY
MAGAZINE



November
1922

**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
Ingot) Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

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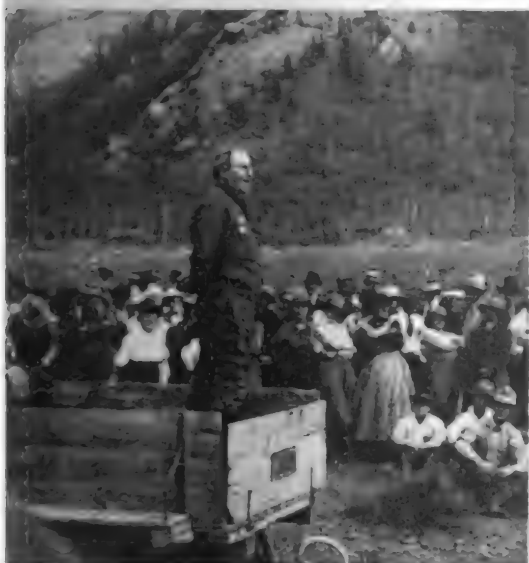
PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIII

NOVEMBER, 1922

No. 10

Opening the Roads



Above we see soldiers and sailors participating in the opening of the new Daniel Webster Highway, described on page 6. Below Congressman Mondell is speaking at Jackson's Hole at the opening of the Hoback Canyon Highway, which runs through the Nebraska wilderness, where once the Robbers Roost Gang held sway. The team of goats was driven by boy scouts from St. Louis, via Minneapolis, to Havre, Montana—1,800 miles—to open the new Glacier Trail.



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Readers are urged to consult with Mr. Graham
on technical questions arising in connection
with highway and reclamation engineering.



This culvert of Armco ingot iron was originally installed in 1909. After eight years it was removed and placed under a concrete road, which is now part of the Daniel Webster Highway. This famous road is described on page 6 of this magazine. The culvert is in perfect condition today.

Part of Pacific Highway Paved 27 Feet Wide

A PORTION of the Pacific Highway extending 4.9 miles to the north from the city limits of Seattle, Wash., is being paved with concrete 8 in. thick and 27 ft. wide. The work is being done by the Washington Department of Public Works, Division of Highways, and is one of those projects on which federal-aid funds are used. The paving is being placed in two 13½-ft. sections with a ¾-in. expansion joint between. The work is to be completed this fall at a total cost of about \$46,800 per mile.

Rubber Roads in the Far East

SOME interesting experiments are being carried out in Ceylon, in the employment of rubber for public thoroughfares, and if these experiments prove a success similar trials may be proceeded with in Calcutta and other parts of India. The first of the new experiments is the use of a rubber mixture, and its efficacy is being tested on certain Colombo highways.

The preparation is applied in the same manner as tar, and resembles it closely in appearance. After application, and before it hardens, the mixture is covered over with river sand to increase its durability. The second experiment is being made with rubber blocks. It is stated that rubber of a very inferior quality, mixed, if possible, with bark shavings, is the best for the manufacture of the blocks required, so that the cost will not be an insuperable objection.

Kentucky Abandons Convict Labor

WITH the lowering of labor costs some states are abandoning the use of convicts on road work. The State of Kentucky has recently announced its intention to discontinue the use of convicts for road work.

During 1919 and 1920, when labor was scarce and high in cost, a number of states pressed convicts into service and for the most part satisfactory results were obtained. New York, California and Nebraska, as well as other commonwealths, have found the employment of convicts profitable.

Safety First in Swamp Fill

By LELAND F. JAMES

Former Instructor, Experimental Engineering and Mechanical Processes, U. S. Naval Academy, Annapolis, Md.

This article describes an interesting swamp fill on an important Federal Aid Project. It is based upon information obtained through personal observation of the work in progress, and through interviews with officials connected with the undertaking, among whom should be mentioned W. J. Wise, road supervisor for ten years in Calhoun County; W. B. Hildebrand, road builder, in immediate charge of the fill work; and J. A. Driggers, manager of the county chain gang forces.

ASIDE from its value in removing a one time barrier from an important connecting highway, by aiding in reducing the steep hill grades and in elevating the road bed through a section of swamp, the earth fill included as a part of Federal Aid project No. 176-A, now under construction by county forces at Little Beaver Creek, Calhoun County, South Carolina, presents several interesting and instructive features.

Especially is this true on the south approach to the creek where, in order to straighten out a sharp curve in the original right of way, it was necessary to offset the fill on the upstream side of the old roadway.

As one of the ingredients of the borrow pit, which was located on the hillside conveniently near the proposed route, a white, fine-grained, sticky clay, locally known as "pipe chalk," was found in suf-



This view shows a part of the swamp fill in Calhoun County, S. C., which is described in the accompanying article.



An interesting use of field stone as a retaining wall for a swamp-lake fill in South Dakota.

ficient quantity to supply material needed for the fill base along that portion of the length where the sides are at any time likely to be exposed to the swamp water.

Pipe chalk clay possesses several advantages for this kind of work. It not only settles quickly into a firm cohesive layer between the surface on which it rests and the remaining body of the fill, but it also becomes at once impervious to the action of water, this last property recommending its use where the more porous materials might become undermined during a season of high flood waters. Moreover, the liberal application of pipe chalk around the inshore ends of the structure is an undoubted improvement upon the more or less cumbersome sand-bag method of protecting against a probable wash under the influence of a swiftly flowing current.

As though nature had made special



This corduroy, or plank, road through a swamp in southwest Washington has recently been rebuilt.

provision for this badly needed road improvement, the wisely-selected borrow pit contained both sand and clay of a quality ideal for mixing into the body of the fill, with enough scattering small rock to throw in along the sides and ends for added strength. In the same pit there was found a limited quantity of that superior light red gravelly clay which will later be used to advantage in mixing the materials for the proposed sand-clay road body.

Earth moving was accomplished with mule teams and wheel scrapers, five mules being employed in loading the scoops and two mules for transporting the wheelers to the fill site. It is worthy of note that sand and clay was dumped in loads so alternated and proportioned that the work of securing the proper mixture for the body of the structure was reduced to a minimum. Layers of earth that could not be readily loaded into the transporting equipment were broken up with plow and tractor.

Pine logs which had been cut away from the site of the borrow pit were placed lengthwise along the hips of the fill to lessen the liability of side-washing during that period required for the added materials to settle into one permanent structure.

A simple but none the less important

feature which may find its application in similar work elsewhere, was that of burying underneath the surface of the hips a growth of joint-grass. This grass re-roots readily and grows rapidly into a thick network which assists in holding the side surfaces intact. The loose grass was brought in from the nearby fields and scattered over the hips along with a few loads of rich soil, after which it was cut into the surface with a sharp pointed shovel. Other kinds of grass or grass seed might be as well adapted for this service in other localities, but in any case it would be advisable to enrich the surface where the selected growth is implanted by the addition of fertile soil or some artificial fertilizer.

Work on the north approach to Beaver Creek has begun and will be completed during the fall, after which the two sections of the fill will be connected across the stream by a 140-foot surfaced plank bridge supported by eight 4-pile driven creosoted bents.

The fill as designed measures eighty-eight feet across the base and twenty-eight feet across the surface. It is of such height that a maximum grade of six per cent is secured on the steepest climb, which brings the new bridge to an elevation of seventeen feet above the original location. When the work is finished there will have been moved approximately 20,000 cubic yards of fill.

The cost of the entire project, which includes hill grading, road surfacing, and bridge building, will be around \$20,000, one-half of which will be paid for out of Federal Aid funds allotted to the county by the State Highway Department, the other half being assumed by Calhoun County.

Arkansas-Louisiana Highway Completed

THE Arkansas - Louisiana highway, pronounced one of the finest roads in the South, is now completed, according to information received from the Arkansas State Highway Department. The entire system is now open to traffic.

The road is 153 miles long. It cost approximately \$3,500,000 and was 3 years and 6 months in course of construction.

Opening Up the Carson National Forest

By JOHN D. GUTHRIE
United States Forest Service

How the tourist and settler will benefit by the new roads being constructed in this National Forest in northern New Mexico.

THE new forest road project in Carson National Forest in northern New Mexico, recently constructed by the Forest Service in co-operation with the Bureau of Public Roads is typical of the many roads and trails now being built in the 149 National Forests of the United States and Alaska.

These National Forests comprise a total of 156,000,000 acres of land and cover largely the rough mountainous portions of the states in which they are located. Within these areas are thousands of scattered settlements in the small open valleys.



An interesting sign in the Carson National Forest.

which were hitherto almost inaccessible except over prohibitive grades.

This road also enables tourists to see some of the scenic wonders of the Taos country, chief of which is the Indian Pueblo of Taos. The road follows the Rio Fernandez from the town of Taos, crossing over the southern end of the Taos Mountains at Palo Flechado Pass, which has an elevation of 9,045 feet above sea level and which is located 18 miles east of the town of Taos.



A typical view of a Carson National Forest road in winter time.

While the forest roads built by the Forest Service are for the most part simply and cheaply constructed and while they are in no sense finished highways, yet they are of the greatest importance to the settlers in the scattered communities in the marketing of their produce and live stock and in the more economic utilization of the timber and forage resources of the National Forests.

The Carson National Forest Road project opens the rich Moreno Valley, a farming community on the east slope and outside the Carson Forest, as well as several small settlements along the route,



The U. S. Forest Service aims to aid the tourist with telephone and camp sites.



Opening the Daniel Webster Highway, near Nashua, New Hampshire, on the New Hampshire-Massachusetts state line.

Dedicating a Highway to Daniel Webster

How this New Hampshire-Massachusetts road connects many points of interest in the life of the great Statesman.

A FITTING tribute to Daniel Webster, jurist, orator and statesman of New Hampshire, was the recent dedication of the Daniel Webster Highway. This 200-mile highway links the Granite State with her sister state, Massachusetts, and runs on through the White Mountains of Webster's state.

The entire length of this new memorial highway is replete with historic interest of the famous orator. It connects Franklin, New Hampshire, the birthplace of Webster, with Concord, where Webster's memorial statue now stands, and passes a few miles from Hanover, where Webster studied at Dartmouth College and on into the White Mountains and Canada.

The memorial tablets stand at the exact division of the states of New Hampshire and Massachusetts not far from Nashua. It was at this point where the official opening of the Highway took place with an impressive ceremony that brought together the officials of two states.

Soldiers and sailors in uniform took

their places beside the flag-draped markers, holding taut a cord which marked the division line of the two states. At a given word the cord was severed, the markers unveiled and Governor Brown of New Hampshire solemnly shook hands with Highway Commissioner Cole, representing the Commonwealth of Massachusetts, across the severed line.

The markers which are on opposite sides of the Highway are of six foot granite slabs, set with bronze tablets. One bears the inscription "The Daniel Webster Highway" and the other, "Union and Liberty, One and Inseparable, Now and Forever." One is shown on the frontispice of this magazine.

The Radio in Road Work

A RADIO broadcasting station has been established in the office of Frank Page, State Highway Commissioner of North Carolina, and receiving stations in each of the nine district offices of the highway department.

A Woman Worker of Road Wonders

Anna M. Kendall, "77 Years Young," Builds 'em for Alabama

An interview by FRANK E. KENNEDY

IN some future time when the history of America's highways and highway builders is written and the honor roll of highway achievement is commemorated in bronze or stone, the name and works of Anna M. Kendall of Washington County, Alabama, will stand with the greatest, if the spirit of service and indomitable purpose count in the realm of achievement.

Mrs. Kendall is the only woman road supervisor in the South, possibly in the world. She has devoted fifty years to the study of roads and roadbuilding in both the United States and Europe. She has seen some of her long cherished dreams come true and yet she feels that she is just getting into the swing of her work—and she is just 77 years young!

Let some of the younger, masculine members of the highway construction profession, who think their lot is hard, consider for a moment the difficulties and problems that have been met with and solved by a woman who has grown-up grandchildren and who is out every day overseeing and planning actual road building and maintenance.

Mrs. Kendall was born in Bureau County, Illinois, but has lived in Alabama for several years. Twenty years ago a



Anna M. Kendall is congratulated by Congressman John McDuffey.

highway in her native Illinois county interested her so much that she started a constructive campaign to have a new one built according to her own ideas. The road commissioners called her efforts and plans visionary and obtained a restraining order against her activities. Ten years later the same county, it is said, offered to pay her for the advice and supervision which it had refused.

After several trips to Europe for the purpose of studying road construction, Mrs. Kendall matriculated in the University of Wisconsin for a course in highway engineering at the same time that her granddaughter, Miss Elizabeth Kendall, started her course in agriculture. The grandmother and granddaughter followed their studies at the same time and were graduated together.

Mrs. Kendall went south several years ago and investigated the farms of Alabama. She located in Washington County and established a model farm. Like many southern counties, Washington is fertile but to a large extent undeveloped; transportation was a big problem.

"I suppose I pestered the highway com-



Cliff Williams and the booster truck employed by the Mississippi Valley Highway Association.

missioners so much that they decided to see what I could do," she stated.

Accordingly, nearly two years ago, Mrs. Kendall was appointed overseer on repair work on some 12 miles of road in Washington County which was in very bad condition, no work having been done on the road for several years.

BEFORE THE STATE COMMISSION

With only the most meager equipment and a few men she started in. A few weeks after her appointment she was called to Montgomery to attend a regular meeting of the State Highway Commission.

"There had come to Washington County out of a clear sky," Mrs. Kendall said, "the possibility of obtaining a link of 26 miles of the Mississippi Valley Highway. Our county commissioners were represented at this meeting by Frank C. Turner, probate judge, our county agricultural agent and myself. Judge Turner presented Washington County's claim for the great highway and then asked that I be allowed to speak.

"I told of the great needs of this long neglected and almost forgotten county which was still a part of the State of Alabama."

Mrs. Kendall modestly refrains from telling what she actually said to the State Highway Commission, but it is a fact that Washington County got the highway and Federal and State construction begins next spring.

HOW SHE DRAINED THE ROADS

With additional equipment obtained from the State Highway Engineer's office on her trip to Montgomery (part of which was taken back on the sleeper), Mrs. Kendall was enabled to accomplish an appreciable amount of maintenance and repair work. She gave her entire time, much of the time of her farm hands, her own team of mules, a farm plow and an old wagon. There was practically no money to pay for labor, but the work was done by men working out their poll tax.

The best proof that her roads are good is the fact that they stand up under heavy rains and the wear and tear of traffic. Road experts admit that she has the finest stretch of road in Washington County.

Drainage is one of the biggest prob-

lems of the south. It is a problem in Washington County.

"I did what had never been done before in this region," Mrs. Kendall states. "Drained the roads. I was told by our county agent that during the past ten years, \$100,000 had been spent on the roads in moving earth alone, yet there were no roads, only tracks and all of them in a deplorable condition."

It is a far cry from the Roman roads and culverts of Europe to the sand hills of Alabama, but this little woman has known both and is transferring her knowledge of one to the other.

Mrs. Kendall is now considered one of the State Highway Department's greatest assets and recently was congratulated publicly by Congressman John McDuffey on the work she is doing.

THE BIG PROBLEM

"Personally, I am a little old woman seventy-seven years old," Mrs. Kendall continues, "but my health is perfect and I am not conscious of being more than twenty-seven. In recent years I have had two very severe accidents which nearly cost me my life, but I pulled through each time with no other serious results than the shortening of my stature two inches, and a stoop in my shoulders.

"I wish that I could awaken every woman to a direct active interest in all methods of transportation, particularly in the road that passes her door.

"The transportation problem is now one of the greatest importance to the American people. The Mississippi Valley will be compelled to solve this problem—and that very soon. We have the greatest need of an educational campaign which will inform the people of the true condition of our transportation system. Our waterways should be developed. The railroads are hardly in condition to handle one-half the freight that will need moving when the nation's crops are harvested, our highways are but partially completed and even those that are, are not always adequately maintained.

"We must have an adequate, scientifically coordinated system of transportation if our national economic life is to develop. What we want is the uninterrupted movement of the products of our farms, mills and shops."

Building a Road to Tamalpais' Top

How a California corporation has capitalized the scenic beauty of Mount Tamalpais through the construction of a toll road for pleasure seekers.

THE Ridge Crest Boulevard, constructed during the past summer to the top of Mount Tamalpais in Marin County, California, adds another scenic-wonderland highway to the ever-increasing number of motor trails that have made California the tourist's Mecca.

From the standpoint of scenic beauty the Mount Tamalpais road offers a charming variety of sea and mountain view. Over the entire length of the boulevard a wonderful panorama unfolds on every side. To the west lies the Golden Gate, the ocean and the Farallones, with Bolinas Bay and Stinson Beach in the immediate foreground. To the east lies San Francisco Bay, and seven counties may be seen from the summit. On a clear day, with a glass, Mount Shasta can be seen on the northern boundary of the state, while St. Helena, Diablo and Mount Hamilton loom out in the nearer horizon.

The construction of the road itself embraces several unique features which are of interest.

The road was built by the Mount Tamalpais Ridgcrest Boulevard Company which was organized through the efforts of the San Anselmo Chamber of Commerce and other Marin County civic associations. No trucks are permitted on the road, which will be a toll proposition, the

money received in tolls being used to meet the expenses of the maintenance crew which will be on duty throughout the year.

To insure the road being a public asset



Engineer John C. Oglesby surveying the Ridge Crest Boulevard.

and to guard against its deterioration into a money-making scheme, it was incorporated in the by-laws of the company that dividends should be limited to ten per cent and that the balance of the net profits derived from the operation of the toll road should be used for repayment to individuals for the cost of construction. After these repayments have been made it is planned to use the income to build further roads, or the highway system thus built may be turned over to the county, at the discretion of the stockholders.

The highway is 24 feet in width and dangerous mountain curves have been avoided. It is surfaced with crushed rock and the problem of drainage has been successfully solved through the use of nearly a mile of Armco culverts along the nine-mile stretch of road, which follows the crests of the hills. These drainage structures will prevent washouts. There are no points where the road does not lie in range of the sun and it will be passable in almost any weather.

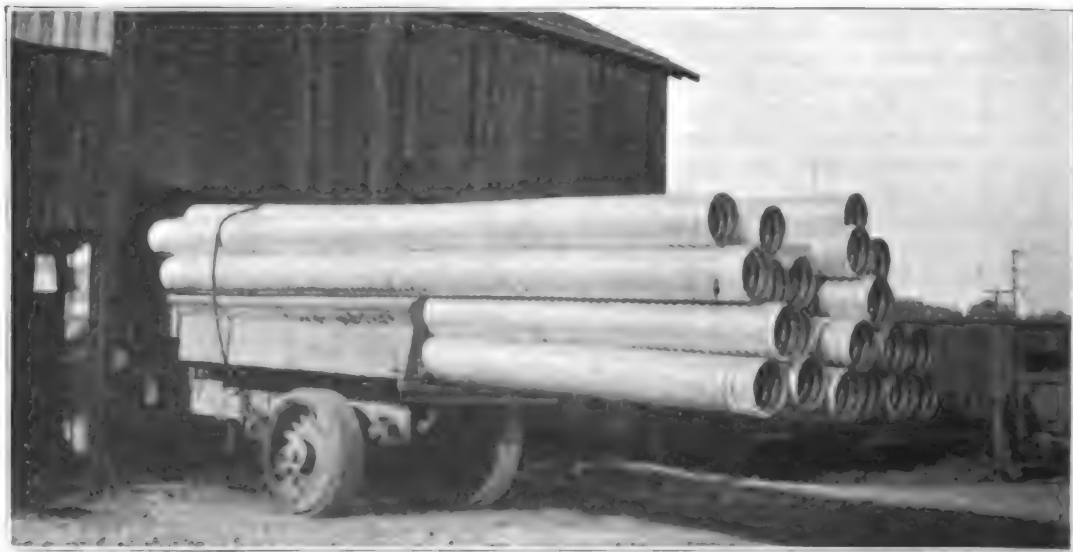
In the completed grade the maximum climb is a ten per cent gradient, which can be made with ease by any make of car without resort to low gear.

The total cost of the nine miles of road is approximately \$100,000. It extends for six miles from Ridgecrest to Rock

Springs and then for three miles farther to the Tavern on Mount Tamalpais. The toll gate is located at the Ridgecrest lodge and service stations and hotels will be erected at both ends of the road. A telephone line will be strung the entire length of the route for the accommodation of motorists using the highway.

The start of the new highway may be approached either from the San Anselmo side through Fairfax or by way of Stinson Beach. There is a winding, picturesque road through Manzanita Canyon and Tamalpais valley, threading through shaded lanes and quiet, wooded slopes. On the top of Tamalpais are the tavern and the marine observatory, where ships are sighted scores of miles out at sea. The government weather bureau station is also located near the tavern, which houses the great seismograph that checks up on all movements of the earth's crust.

The declared purpose of the highway is "to awaken the North of the Bay counties to the advantages that will be derived through active construction of roads through the scenic districts of the counties. Through the conception and organization of the Mount Tamalpais Boulevard plan, the moving desire has been the development of the beauties and wonders of Marin County."



A truck load of 12-inch Armco culverts used in the construction of the Ridge Crest Boulevard which extends to the summit of Mount Tamalpais.

Pedestrians, Keep to the Left!

By THE EDITOR

During a recent three-thousand mile motor trip we passed hundreds of pedestrians on the public highways. Not a single pedestrian observed the safety-first rule—"Keep to the LEFT"—which applies in all countries where horse-drawn and motor-driven traffic keeps to the RIGHT.



When wheeled traffic keeps to the right, the pedestrian should keep to the left.

WHERE the traffic law requires that motor-driven and horse-drawn vehicles keep to the *right* on the public highways, pedestrians should walk on the *left* side of the road. In countries where the reverse is the rule for wheeled traffic, those who walk the roads should keep to the *right*.

At first this rule may seem illogical, but when one stops to consider that where traffic keeps to the right, the pedestrian who keeps to the left will always be *facing* the vehicles which travel on his side of the road. If the walker keeps to the right the vehicles, also traveling on the right, will approach him from *behind*. He must depend on his hearing and on the sight of the driver for his safety. If, on the other hand, the walker keeps to the left, he can see as well as *hear* the on-coming vehicle and, if necessary, step off the road to permit the motorist to pass.

We noted hundreds of pedestrians on

the highways during a recent three thousand mile motor trip through the central and eastern part of the United States (where all traffic keeps to the *right*) and not a single one of these persons kept to the *left*.

The hens and ducks and geese seem to have developed a little wisdom during the last twenty years of motorization of traffic, and now avoid the heavily-travelled highways bordering their farm-yard homes. They pick for bugs in the ditch and keep off the pavement.

But human beings, it seems, have not learned this lesson, and it is safe to say that thousands, yes, tens of thousands of pedestrians are in danger on the public highways every day in the year because they do not walk on the correct side of the road. That more are not run down and killed or injured is due, in a great measure, to the care exercised by motorists who, with quickly-sounded horn and hastily-applied brakes, avert the tragedy made so possible by a non-observance of the safety-first rule.



Even the geese have learned the "Safety-First" rule.

Auto Club Employs Private Highway Patrolmen

By K. H. LANSING,
Special Correspondent for *The Highway Magazine*

How an automobile club finds its own road guardians valuable in warning of dangers; reporting on road conditions; erecting signs, and nullifying "Speed Traps."

ROAD patrolmen mounted on motorcycles are being employed for the first time in the East by any private organization of motorists. The Keystone Automobile Club, of Philadelphia, which has a large membership, is the leader in this unique departure.

The main duties of the patrol are: to furnish road information to club members and tourists generally; warn motorists against "speed traps" laid by cunning constables for purposes of graft; report at once any defective road condition; put up direction and warning signs; warn offenders where Motor Vehicle Act provisions have been violated, and help the club's traffic committee to take the traffic census.

Tourists from other sections, who have wandered out of their way recently, have been agreeably surprised when

hesitating confusedly at crossroads in various parts of Pennsylvania, to be accosted by a handsomely uniformed man on a motorcycle, who inquired if they wished to be directed, then gave the desired information clearly and concisely, presented to them a road map bearing the name and address of the Keystone Automobile Club, touched his cap and rode away. They told their friends and acquaintances of the incident, and, of course, they looked up the Keystone Automobile Club. The desired end of the latter was then gained.

Other large automobile clubs in Pennsylvania and adjoining states are watching with interest the outcome of the system which, it is generally admitted, has made a notable start.

The first club road patrolman was put on early in May. In addition to his motorcycle, he was furnished with a sidecar of the usual van type.

Only thoroughly reliable and courteous patrolmen are employed by the club, and they must be able to "make speed" in emergencies.

By designating certain first class garages in each locality as "official" Keystone Automobile Club garages, the organization has a system of quick communication between the main office of the club in Philadelphia and its motorcycle patrolmen at various points.

The patrolmen now average about one hundred miles a day, six days in the week. The patrolman nearest Philadelphia covers three large counties—Montgomery, Chester and Delaware. His "beat" extends to Philadelphia on the east, the state line on the south, Phoenixville and Norristown on the north, Downingtown on the northwest and Oxford on the west.

Praise is heard from many sources for the Keystone Automobile Club's new plan, and it is expected that other large eastern clubs will soon follow suit.



One of the private patrolmen employed by the Keystone Auto Club.

Irrigation and Drainage

Miami Conservancy Construction Stands the Test

*How a recurrence of the "Dayton Flood" is made impossible
by control of flood water in the Miami Valley.*



A bird's-eye view of the development in the Miami Conservancy District at Taylorsville.

IN the spring of the present year, approximately seven years since the Miami (Ohio) Conservancy District was established, the dams which form a part of this great flood control project had their first real test, and although a 14-foot rise of water came rushing down the Miami Valley, the enormous system of levees and dams which had been seven years in the building, demonstrated their ability to more than take care of flood waters.

The Miami Conservancy District was established June 28, 1915, for the purpose of building and maintaining flood control work in the Miami Valley (Ohio) to prevent the recurrence of such disasters as the 1913 flood.

The Miami Conservancy District is a political subdivision of the State of Ohio



A pair of Armco culverts which resisted the ravages of the Dayton flood.



How roads in the Miami Valley were inundated before the Miami Conservancy development. This road is in Logan County, adjoining Shelby.

which includes portions of nine counties, namely: Montgomery, Shelby, Miami, Clarke, Greene, Warren, Preble, Butler and Hamilton.

The Miami River drains the southwestern portion of the State of Ohio. The total length of its winding course is 163 miles. While draining of swamp lands, tiling, cultivation of farms, and the destruction of forests have slightly increased the run-off, the tremendous floods that sweep down the valley are due primarily to the great storms which occur at intervals in that section of the United States.

The great disaster of 1913 which precipitated the action finally resulting in the establishment of the Miami Conservancy will long be remembered.

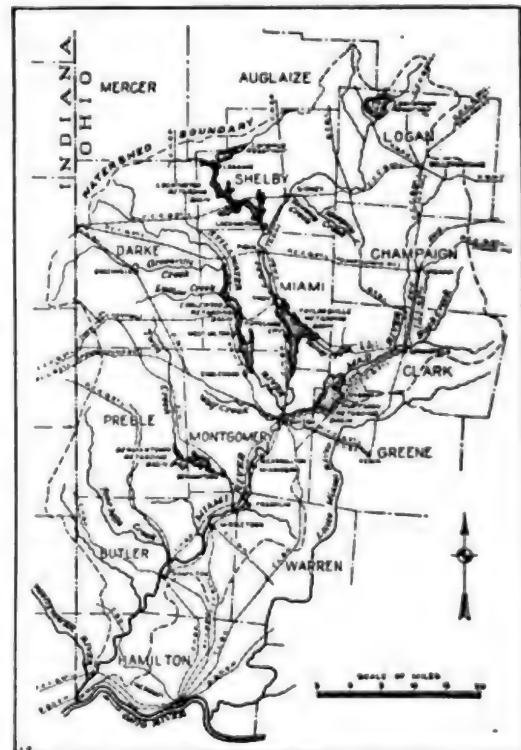
From Sunday, March 23, 1913, until Thursday, March 27, the Miami Valley was swept by a tremendous storm. The streams of the valley, fed by the steady downpour, rapidly rose and overtopped the levees. Tuesday, Wednesday and Thursday the waters raced through the city streets. The water was 12 feet deep on Main Street in Dayton. Thousands of people were marooned for three days and nights in the attics and on the roofs of their dwellings. Over 400 lives were lost and \$100,000,000 worth of property was wiped out, while the smaller commu-

nities of the valley were prostrate as the result of the calamity.

With great determination the citizens accepted both their individual and community losses, cleaned up the wreckage and re-established their businesses. Martial law was declared and the militia patrolled the streets of the towns enforcing order. Every able-bodied man was put to work. Food was distributed and tents were supplied to the homeless. Business arranged for credits so that normal business could be resumed.

Strengthened by disaster and self-sacrifice, the communities emerged from the wreckage with an added vigor and courage which has been reflected in the wonderful progress the valley has made since 1913.

Before the wreckage was cleaned from the streets, the citizens, with the same courage and determination that marked the rehabilitation of their personal affairs, faced the problem of preventing the recurrence of such a calamity. Acting through the several Citizens' Relief Committees, funds were raised, and engineers employed to study the problem. Within



THE MIAMI RIVER AND ITS DRAINAGE AREA

sixty days after the flood Dayton alone raised a fund of two million dollars, twenty-three thousand individuals contributing. The Dayton Committee first employed the Morgan Engineering Company of Memphis to work out a plan for flood prevention for Dayton. As the investigations progressed it became apparent that the difficulties in securing a satisfactory solution to the big problem were so great that the individual communities could not meet them alone, and that cooperative action of the entire valley was necessary. The retarding basin-channel improvement plan developed into the most satisfactory comprehensive plan for the protection of the entire valley, and was adopted as the official plan of the District.

The drainage area of the valley is about 120 miles long and covers 6,272 square miles. The work of constructing dams and levees was stupendous. An idea of the great quantities of materials involved in this project can be gained from the fact that 21,317,000 cubic yards of earth and rocks had to be moved. The entire construction and maintenance cost to the present time totals \$35,000,000. Most of the earth and rock used in the construction of the dams was moved by the hydraulic method. Several thousand feet of special welded dredge pipe was used in the work.

One of the big problems in the hydraulic work was the securing of an adequate water supply from the Miami River. After some consideration the engineers decided to pipe the water from the river to the various locations by using 36-inch corrugated culverts.

Armco culverts were selected for the purpose and shipped to the job ready to install. Elbows were made to conform to the special requirements of the work. In carrying out an undertaking involving such a large amount of territory, it was necessary to relocate highways, railroads, and in one instance, move an entire village.

On the last day of last year (December 31, 1921) the last of the five great dams was completed, providing for a total of 847,000 acre feet of water under maximum flood conditions, thus giving the Miami Valley protection against the recurrence of another 1913 disaster.



A number of 36-inch Armco culverts used by the Miami Conservancy to obtain sluice water from the Miami river at the Taylorsville dam site.

Use R. F. D. Men as Highway Reporters

THAT they may be constantly informed as to roads that are in need of repairs, the Marion County, Ind., Board of Commissioners has adopted the plan of utilizing rural mail carriers as reporters and the commissioners say the idea is so practical that it can readily be followed in other parts of the country.

The rural carriers travel over the roads of a county every day, like the spider travels over its web. They are so familiar with surface conditions that they know the location of every break in a paved highway and every hole in the unpaved. The plan in Marion county has been worked out by Warren C. Rumford, superintendent of roads, and Postmaster Robert H. Bryson, of Indianapolis. The rural carriers are supplied with blanks on which information relative to any road may be written. The mail carriers will turn these reports of needed repairs over to the assistant road superintendent in the particular district and he, in turn, will hand them to Mr. Rumford.

Conveying Oil Over An Irrigation Canal

How a pure iron flume was employed as an oil carrier by a California land company, after a wooden structure had burned.

THE problem of carrying oil over an irrigation canal without polluting the irrigation water lead to a unique installation in 1915 by the Kern County Land Company, of Bakersfield, California.

In order to carry off crude oil for the purpose of burning it in a place of safety, in the Kern River Oil Fields, Engineer Frank Whitaker installed a length of small-diameter Armco ingot iron flume over an irrigation canal, after a wooden flume used for the same purpose had been burned out.

The accompanying photographs show this installation after it had been in service seven years, when a thorough inspection showed that the flume did not leak a drop, nor had any signs of rust or deterioration developed in spite of the severity of this type of service.

The same two problems—prevention of fire and elimination of leakage—are as highly important in flume installations for irrigation purposes as for transporting oil.



An Armco flume being installed in the Kern river oil fields to carry crude oil across canals. Engineer Frank Whitaker is in the picture.



Another view of the Armco flume installed by the Kern County Land Company, at Bakersfield, California. This flume has carried crude oil across an irrigation canal since 1915, and is in perfect condition. It was used to replace a wooden flume which burned out.

Feeding the Brute to Discover Its Habits

ARMCO
INGOT IRON
Resists Rust

THIS picture shows the testing yards where we continually feed metal to the great iron-eater—rust.

Snow and rain, cold and heat—all the elements are given a chance to show their power of destruction on sheets of ARMCO Ingot Iron and other metals.

When the metal sheets have been there for months, the chemists and metallurgists examine sections under a powerful microscope. To an outsider, the difference in effect on ARMCO Ingot Iron and other irons would be a revelation.

The survival of ARMCO Ingot Iron is due to its purity. Foreign matter that invites rust has been eliminated during the special process of manufacture.

These testing yards and our extensive research laboratories are indications of the great, unceasing care taken to maintain the purity of ARMCO Ingot Iron. If you are a user of iron products where rust-resistance is required, write to us.

Snow-covered Testing Yards at ARMCO Plant



This triangular trade-mark on culverts, flumes, siphons, tanks, road signs, roofing, etc., is your assurance of quality and unequalled rust-resistance.

The American Rolling Mill Co.
MIDDLETOWN, OHIO



This ARMCO Ingot Iron culvert has been under main line traffic for ten years without impairment

EVEN on the smooth surface of rails the impact shocks of traffic are figured as several times the dead load. On the comparatively rough surface of a highway—especially after several years' use—the impact loads are correspondingly greater, compared with the dead load values.

ARMCO CULVERTS

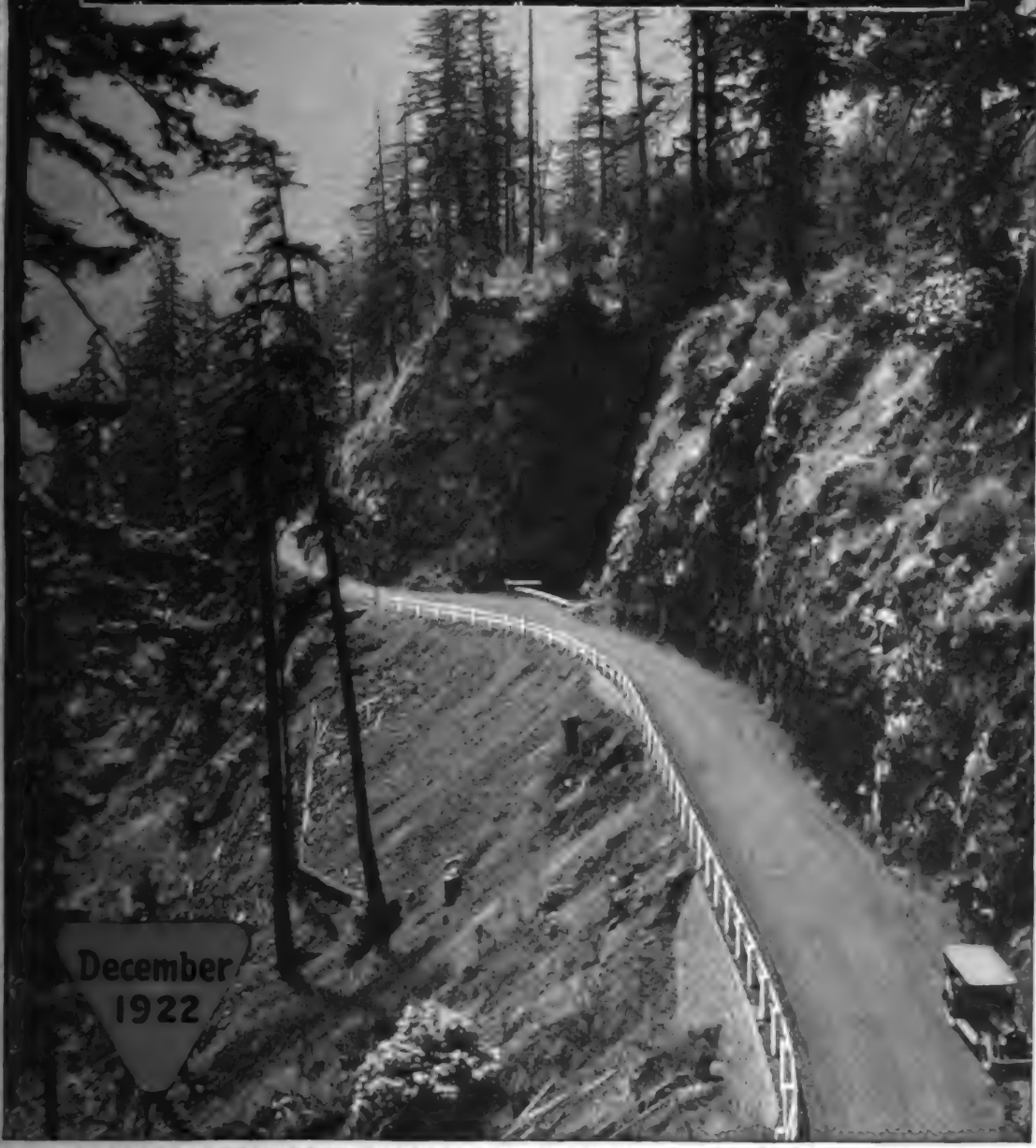
are designed to withstand the heavy impact stresses that would shatter culverts of brittle materials. They are in use in railway work with only a slight protecting fill and under the most densely traveled highways.

The purity of the ARMCO Ingot Iron maintains the structure against corrosion and insures long life and serviceability.



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The **HIGHWAY MAGAZINE**



December
1922

**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
Ingot) Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Calgary, Vancouver, Vernon

The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

Vol. XIII

DECEMBER, 1922

No. 11

Queer Pavements



TIN CANS AND WHALEBONES FOR ROADS

London is being paved with tin cans. A Liverpool company is melting old tins into pavement blocks. The photos at upper left and right show the tins being shoveled into the furnace and a pile of the metal blocks being moved for shipment. Below is shown a pavement of whalebone which was built years ago in Monterey, California. It is perhaps the only road in the world made of this material.



DECEMBER, 1922

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Readers are urged to consult with Mr. Graham
on technical questions arising in connection
with highway and reclamation engineering.



A view of one of the model construction
camps used by the builders of the Berthoud
Pass Highway, which is described on page
11 of this magazine.

That's Tellin' 'Em!

OVER a particularly smooth innocent-looking section of road in the Dixie Bee Line Highway in Tennessee swings a 40-foot sign bearing the inscription: "Drive Slow—Dangerous as the Devil."

This sign has had its effect for residents there say only one fatal accident has occurred along that piece of road in 10 years—and as one old-timer tersely put it, "That durn fool was full o' mule, had a 3 to 1 gear on his flivver and couldn't read anyhow."

Dean Anson Marston on Culvert Loads

IN this issue of *Highway Magazine* is presented the first of a series of authorized interviews with Dean Anson Marston, of the Department of Engineering, Iowa State College, by Louis A. Graham, M. E., on the important subject of "culvert loads."

As Dean of the Engineering Department of Iowa State College, Dean Marston is ex-officio State Highway Commissioner for Iowa, and has filled the double office since 1904. This gives him the distinction of having served continuously as State Highway Commissioner longer than any other man in the United States.

The opinion has many times been expressed that Dean Marston has helped put the State of Iowa on the highway map. Certainly, good roads have done much for Iowa, and the Dean has been identified with the good roads movement from the very start.

It is interesting to note that—

There are more automobiles per unit of population in the State of Iowa than in any other State in the United States. The entire population of the State might comfortably be transported elsewhere via its own automobiles, although the Dean claims that an Iowan prefers to stay at home.

Again—

Iowa is the only State where the Highway Commissioner's office is located away from the State Capitol. In Iowa the Commissioners' headquarters are at the State College at Ames.

Last, but far from least, Iowa claims for its own the—"headlight of the highway"—Thomas H. MacDonald, head of the Bureau of Public Roads at Washington. And Dean Marston modestly claims credit for the discovery of "Tom" MacDonald, who, before going to Washington, was Chief Engineer for the State Highway Commissioners for Iowa.

Despite the fact that Dean Marston had passed the military service age, he enlisted for active duty during the War, and served continuously with troops in the field, attaining the rank of Lieutenant Colonel, Corps of Engineers.

Ontario Has Big Road Mileage

THE network of roads covering the Province of Ontario, which is slowly, though steadily, being improved, total 49,875 miles. On nearly two-thirds of this great mileage paving work of varying nature has been performed.

Photographic Records Aid Idaho Road Construction and Maintenance

By A. S. MAC DOUGALL

Assistant Engineer, Bureau of Highways, State of Idaho

The author describes a unique and thoroughly efficient photographic record system which has been adopted by Idaho and is being employed with signal success.

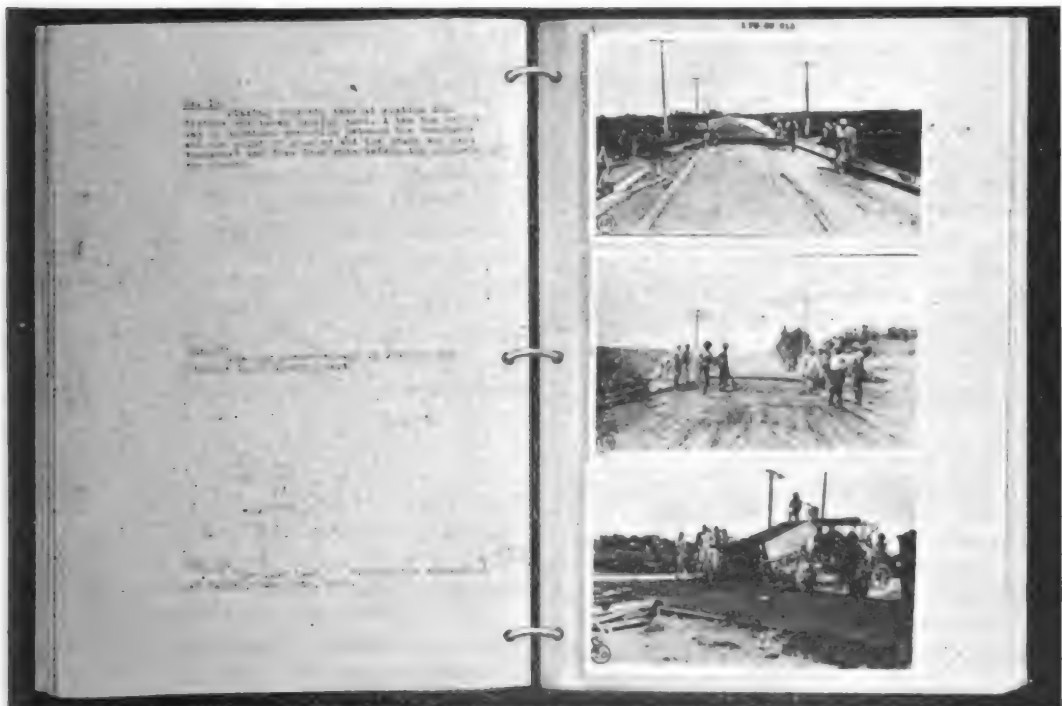
BELIEVING that the camera has a better memory than either contractor or engineer, and feeling sure that it is utterly incapable of bias or prejudice, Director D. P. Olson of the Idaho State Bureau of Highways has in active operation a system of photographic record keeping which saves time, trouble, anxiety and clerk hire, and yet has proved remarkably efficient.

Settling a disagreement by going over the newly finished road with only a copy of the plan and profile to aid in visualizing what construction difficulties and obstructions had been encountered in the original terrain was once one of the joys of the Director of the Idaho Bureau. To add to the hilarity of the occasion, he was usually accompanied by an irate contractor, a distracted resident engineer, and a neutral Bureau of Public Roads in-

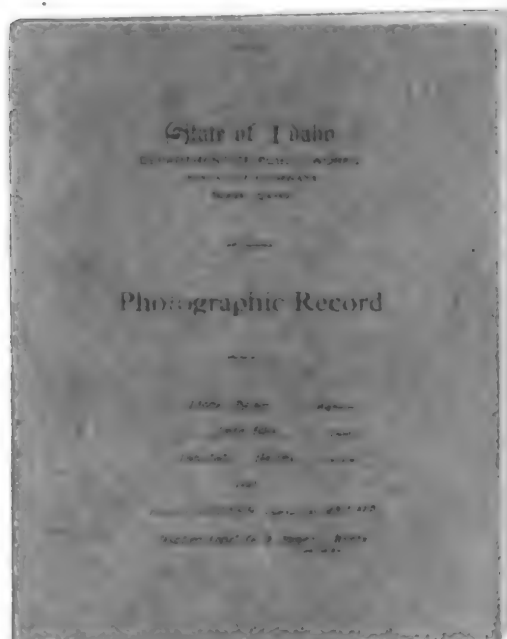
specting engineer. These controversies rapidly became a serious matter, interfering with the proper functioning of the Bureau personnel, and affecting its relations with the contractors.

This difficulty could have been handled, of course, by introducing a series of frequent inspections by the Director or his representative on each project, making tours so often that the general office could have been intimately informed on all special features to be solved on all projects. The Bureau was unable to add to its organization to provide such a system for handling these matters and the records that necessarily would have piled into the central office, and a further difficulty would have been experienced in procuring the type of men necessary in an undertaking of this sort.

Various methods of reports were re-



A typical double-page spread of one of the photographic record books



A reproduction of the cover of one of the photographic record books employed by the State of Idaho in construction and maintenance work.

quired from the resident and location engineers in the fall of 1919 in an effort to relieve this situation. Under one of these methods, each location engineer was required to photograph his contemplated line. Special attention had to be given any feature that might lead to difficult construction. Pictures were made of the terrain at these points, giving all the detail possible, and these photographs were accurately referenced to the nearest station on the preliminary plan and profile. The advantage of this was immediately recognized, and it became an integral part of preliminary location.

PHOTO SYSTEM HAS MANY ADVANTAGES

It was a natural development that this idea should be carried into construction. As the construction proceeded, further progress in preventing acrid discussion was achieved by further pictures (taken with contractor's knowledge and consent) of various phases of construction as the work went forward. On completion of the work, it followed naturally to complete the circle by photographing the finished sections of the road, particularly

the sections that had presented problems in the original plan.

The advantages derived from this system were immediate. It eliminated various other methods that were being tried out and led to a clear understanding of all matters appertaining to each project without increasing inspections or adding to the personnel of the Bureau. The instructions to District Engineers were immediately changed to include not only the preliminary location survey, but also the photographing of construction phases and the completed sections of each project.

HOW RECORDS ARE KEPT

The photographs, in the records as kept at the present time, are made by the location and resident engineers with a 3-A Kodak, equipped with a special lens to aid in emphasizing detail when necessary. When needed, still larger pictures are made. These are bound in a folder capable of containing about thirty light cardboard sheets, and thirty white second sheets. The size adopted for convenience was 9 inches by 11 inches for the inside sheets and 9½ inches by 11½ inches for the folder. The pictures are mounted on one side of the cardboard sheet, each sheet containing two photographs. In the case of pictures smaller than postcard size, the number is increased to three. The white sheets serve to protect the photographs as well as to contain explanatory matter pertaining to them. The Idaho office has found this size to be very satisfactory as it permits plenty of space on the white sheet for notes covering the picture opposite, and is still small enough for convenient filing and for carrying in a portfolio. Photographs of the cover and of a typical two-page spread taken from one of these record books are herewith reproduced.

Four photographic records are made of each project. One remains in the file of the District Engineer in whose territory the work is done, one is retained for the files of the Bureau, and two are forwarded to the District Office of the Bureau of Public Roads, one of the latter number to be forwarded to Washington, D. C.

This same scheme is also fully carried out in reconstruction and maintenance. The accompanying pictures numbered 1,

and 2, showing the extent of the damage done to a state highway along the north fork of the Payette river south of Cascade, Idaho, by high water and slides which resulted from the Spring thaw of 1922, illustrate the use of the system. These photographs were, of course, accompanied by a description of the damage done, with estimates of cost for temporary and permanent repairs.

Picture No. 3 shows the detail of the log cribbing necessary to support the bank and hold it in place. The cribbing is securely anchored at the bottom and logs running back into the bank hold it in position laterally. The ends of the logs driven into the bank are securely fastened to the logs in front by heavy, substantial iron rods.

In the early part of 1920, certain estimates on completed projects were held up for some months while differences between resident engineers and contractors were settled by check surveys run by unbiased engineers. In the absence of a photographic record, this controversy finally had to be settled by conferences held in the central offices of the Bureau of Highways and, even then, each party had to rely heavily on the other's spirit of fair play. Now that photographs are being made of each phase of the construction as it proceeds, such difficulties cannot possibly arise.

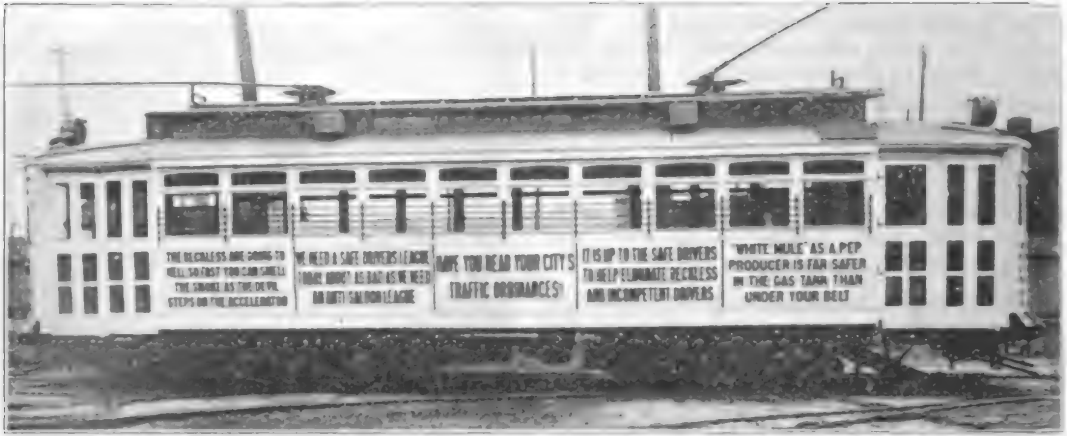
OTHERS CAN PROFIT BY THIS PLAN

These photographic reports have, indeed, proved of value in so many different ways that the Idaho bureau has found them an invaluable addition to the records of each road project which it undertakes. And they can, of course, be made of still further service as the field engineers realize the direct personal benefit they derive from them. This is especially true in preliminary surveys and it is the policy of the bureau to develop this idea as far as it affects economy of grade and design in location.

Idaho believes that the photographic record is here to stay. Other state highway departments are certain to find that they will save money by equipping their engineers with kodaks and instructing them to "fire at will."



A photographic report of damage done by high water and landslides to an Idaho highway. Photos Nos. 1 and 2 illustrate the damage, while photo No. 3 shows the detail of the log cribbing necessary to support the bank and hold it in place, as described in the accompanying article.



The citizens of East St. Louis, Ill., are reminded daily of the dangers of reckless auto driving when they see the signs painted on the side of this electric car. This is the "ghost" car. All other cars are painted yellow.

Little Billy and the "Chu-Chu" Train

THREE-YEAR-OLD Billy was digging in his sand pile one Sunday afternoon. Now and again he was startled by the roar and clatter of the railroad trains which rushed by a few yards away. He called them the "chu-chu cars" and loved to go with his father to see the big engines as they stood panting at the station.

On this particular Sunday, Billy's father was sitting on the porch, thinking about how nice it would be if he could afford to own an automobile and take his family for a ride in the country. Just then a big comfortable touring car with a load of laughing children swept up the street. "I wish I were driving that car," thought Billy's father.

Screams, mingled with a grinding roar and a startled screech from a locomotive whistle, sent Billy's father dashing down the street to the nearby railroad crossing. When he arrived, the train was many yards down the track, but the automobile, a mangled mass of metal, lay crushed against a telephone pole. The children who were so happy a moment before—where were they? Just where the hurtling wreck had tossed them—and they would never laugh again.

Little Billy was playing in his sand pile. He was making a "chu-chu train"

out of his battered blocks and he didn't understand why his mother came out of the house and cried, and his father gave him such a big hug and cried a little, too.

So when Billy's father bought an automobile, he always paused before crossing the railroad tracks, for he thought about that Sunday afternoon when the laughing children had died because someone did not "stop, look and listen."



The inserted newspaper clipping tells the story. They didn't "stop and look and listen."

What Is the Load on the Culvert?

An interview with DEAN ANSON MARSTON* by LOUIS A. GRAHAM, M. E.

This is the first of a series of interviews with Dean Anson Marston, of the Department of Engineering, Iowa State College, and one of America's pioneer road builders. In these interviews the Dean gives the results of the original and far-reaching tests he has been conducting for a number of years at Ames, Iowa, in conjunction with the United States Bureau of Public Roads.

CULVERTS have been used under roads since the days of the Ap-pian Way, but until a few years ago, no one apparently ever tried to determine just what loads they must carry—and how conditions of the soil surrounding the culvert affect the load.

In 1913 we began making a series of such determinations, and except for necessary delays in improving and changing equipment, we have been conducting the experiments ever since.

DESCRIPTION OF THE APPARATUS

The apparatus used to determine the loads on culverts is shown in the photographs 1, 2 and 3. We built two concrete headwalls about 20 feet high and 20 feet apart, making it possible to test a culvert 20 feet long, under an embankment as high as 20 feet.

Instead of using an actual commercial culvert a structure was designed to simulate this type of conduit, receiving and transmitting to a weighing apparatus the loads which would come on a culvert under the same conditions.

The test culvert was circular in shape, 40 inches in horizontal diameter, fabricated of wood planks on iron ribs. It was built in ten 2-foot sections connected only by tin flashings, so that the sections operated independently. The load on each section was carried separately on a beam that passed through the culvert, and rested on a scale outside. There were five scales on each end of the culvert, each one measuring the load on a culvert section.

TESTS UNDER "PROJECTION CONDITION"

Our first series of tests represented a culvert under a fill in the road, rather than in a cut. Normally a culvert in a fill projects above the earth bed (giving

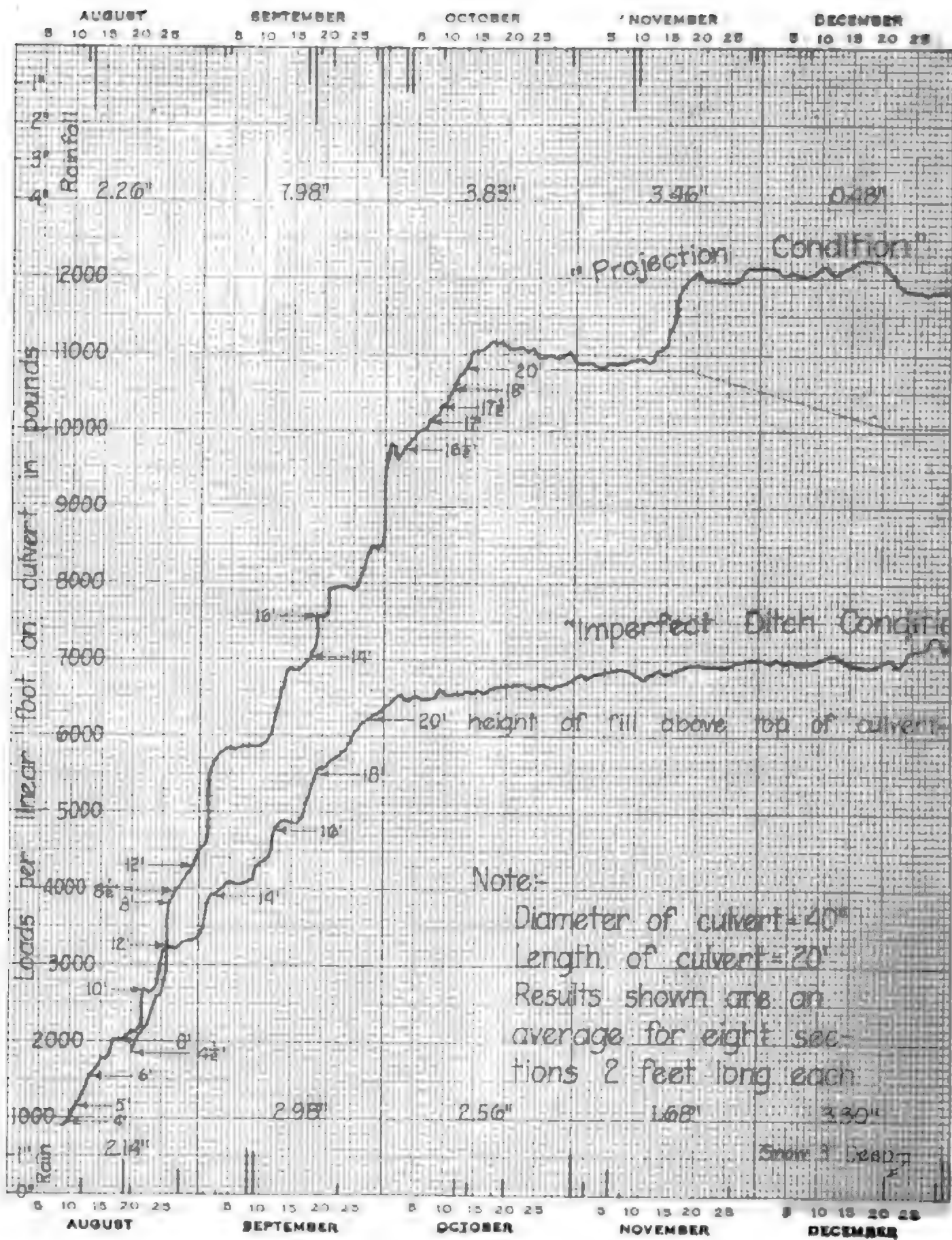


(Photo 1.) A view of one of the end walls in the structure used for testing culvert loads.



(Photo 2.) Beams resting on the scales which determined the loads on the culvert.

*See Biographical Note on Page 2.



(Chart 4.) This chart shows the loads per linear foot on the test culvert in pounds, under both the "Projection Condition" and the "Imperfect Ditch Condition" described in the accompanying article. Readings were made over a three-year period.

what we term "projection condition"). In common practice the earth is thrown loosely over the culvert to the required height, and is either allowed to settle naturally to a firm bed, or the action is hastened by rolling.

In the first set of experiments sandy loam top soil, weighing 96 pounds to the cubic foot, was used for embankment material.

The top curve, in Chart 4, gives the results of the readings during the year 1919-20, and it will be noticed that the fills varied from 4 to 20 feet. Tests at the 20 foot fill were prolonged for several months, to determine the effect of settlement and variation in weather conditions.

HIGH INTENSITIES OF LOAD

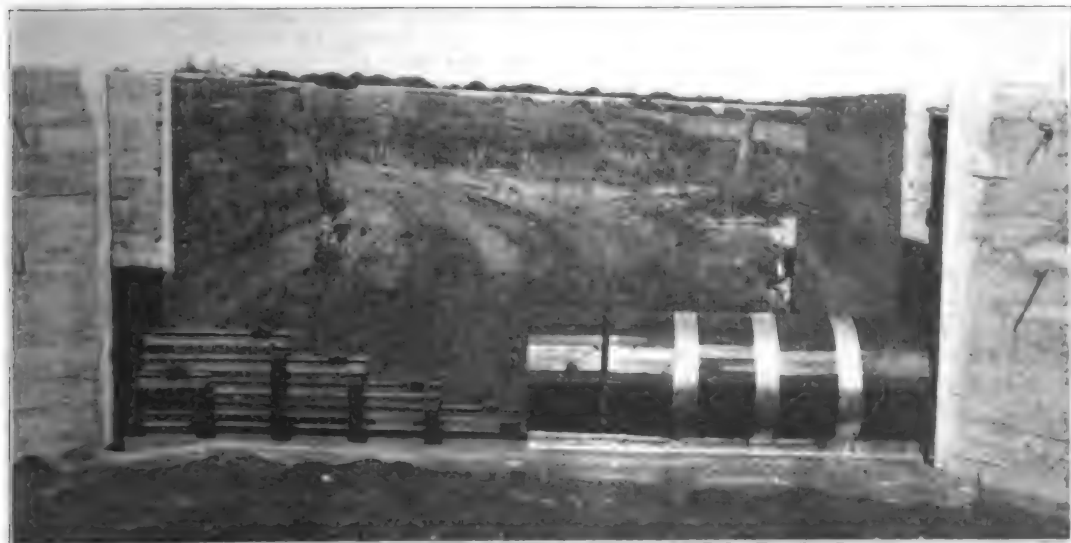
The results were a revelation to many road engineers. We found that the culvert had to carry a load far greater than had been anticipated. In fact, each 2-foot section, in many cases, carried nearly twice the weight of the earth above it. For instance, under a 20-foot fill the average for the several months is more than 11,000 pounds, and the maximum reached January 5, 1920 is 12,257 pounds per lineal foot.

This amounts to almost twice the weight of the material immediately above the culvert, in this case, 6,240 pounds.

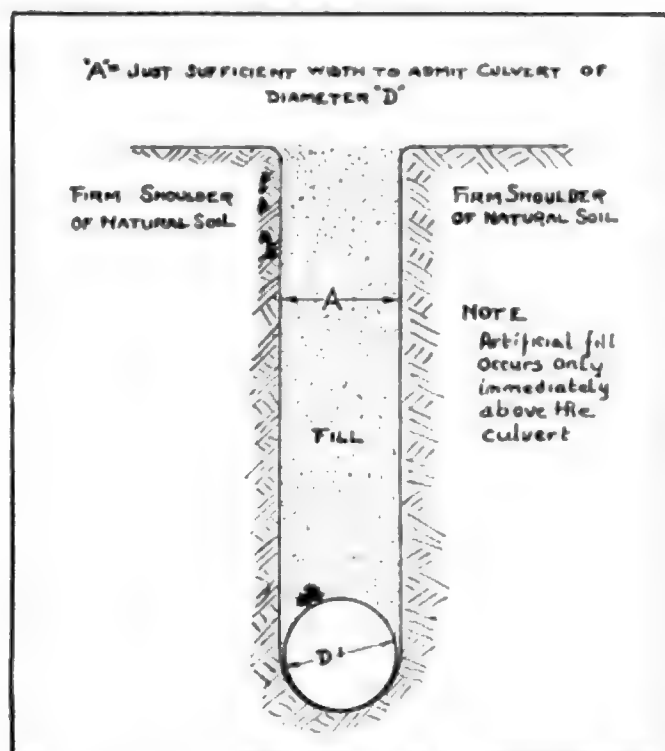
The extraordinary intensity of the loads borne by culverts under "Projection Conditions," as shown by these experiments, will account for the frequent failure of several types in common use. For instance, field investigations by the Iowa State Highway Commission have established that 35 per cent of certain highway pipe culverts examined in actual use showed cracks. Extensive tests on some good culvert pipe showed that even the strongest pipe tested was incapable of sustaining, without cracking, such loads as were obtained under the larger fills in "Projection Conditions." (See Chart 4.)

These results naturally brought up the question—how could the load intensities of the embankment material on the culvert be decreased when in fill? It will be noted that practically all culverts placed at any great depth in road work are in fill. Tests that had been made some years previous on tile pipe under "Ditch Condition" suggested the answer. These tests had shown the loads at 20 feet height of embankment using 96 pound material to be 2,385 pounds or only $1/5$ the maximum load, found in our "projection" tests.

A "Ditch Condition" exists, of course, when a cut of just sufficient width to admit the culvert, has been made in the



(Photo 3) A general view of half of the test culvert before the fill was made, showing beams to carry loads on the remaining sections.



(Sketch 5.) Above is shown a sketch of a "ditch condition," described on this and the preceding page of this article. A pure ditch condition is usually neither feasible nor desirable in culvert practice.

earth bed, leaving a natural wall of firm earth on each side. (See Sketch 5, above.) "Ditch Condition" occurs most often in drainage work.

The *pure* ditch condition is usually not feasible or desirable in culvert practice. We felt, however, that we could *approximate* this "Ditch Condition" in a practical way, and so effect a considerable reduction in the resultant load on the culvert. To do this, an embankment was built of the same sandy loam top soil as before, over the culvert, and to a level 4 feet above its top. The material was deposited in layers and consolidated with a road roller. A vertical trench was then dug down to the culvert, and entirely cleared of material. On completion of this trench it was refilled with material deposited in the loosest possible condition. The construction of the embankment was then continued to the 20-foot level, in the regular manner.

REDUCTION OF LOAD UNDER DITCH CONDITIONS

This expedient cut down the load intensity to a marked degree up to the 12-foot level, the weights corresponding closely to those on pipes in ditches.

Even above the 12-foot level the loads were materially lighter than those found in "Projection Condition," the maximum encountered during the winter of 1920-21 amounting to only $\frac{2}{3}$ of the 1919-20 maximum. The loads in the 1920-21 tests are shown in the second curve in Chart 4, marked "Imperfect Ditch Conditions."

By way of summary, the two facts determined in these series of tests were:

1. *The surprisingly great loads that must be borne by culverts under ordinary conditions of fill, the intensity of load amounting to nearly twice the weight of the earth above the culvert.*
2. *The possibility of reducing these intensities by establishing an approximate ditch condition for the culvert.*

As a result of these two series of tests, and by reference to long continued experiments previously made on drain pipe under ditch conditions, it was possible to develop a formula for calculating the load carried by a culvert for any given diameter, nature of soil, earth condition and depth of fill. These formulae will be discussed in some detail in an article next month.

LOAD DISTRIBUTION ALONG THE CULVERT LENGTH

It may be remarked that the loads shown in the curves represent the average of the 8 center sections, the two end sections having been omitted. The loads on the two end sections were materially less than the load on the center sections, due to the vertical frictional resistance offered by the end walls—this in spite of the fact that the face of the abutments had been reduced to a minimum to obviate this very tendency.

This opens up an interesting question as to the distribution of the load along the length of a culvert, due to the weight of embankment material. This also will be discussed in a subsequent issue.

Read the authorized interview with Dean Anson Marston on "How to Compute Culvert Loads," in "Highway Magazine" for January.

The Road Over Berthoud Pass

How a pioneer's trail to wild game and gold has now become a famous highway, through the efforts of the United States Bureau of Public Roads and the State of Colorado.

EVER since the first white trapper followed the Indian and wild game trails over Jones Pass, which crosses the Continental Divide between Torreys Peak and Jones Peak, in Colorado, the journey through this mountainous region has been fraught with hardship and danger. But now the finishing touches have been made on a great highway over Berthoud Pass, five miles north of the old trail, and today the motor vehicles glide along where the burro once struggled for a footing.

Building the Berthoud Pass Highway was a man's job, and to the men—repre-



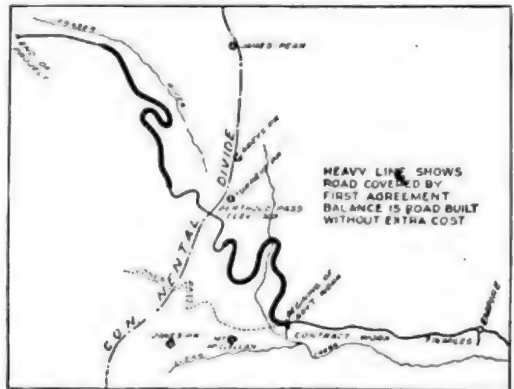
A steam shovel at work on the Empire side of Berthoud Pass.



The finished road. Berthoud Pass Highway on the Empire side.

sentatives of the Bureau of Public Roads and the State of Colorado—who planned and executed this undertaking, full credit should be given. J. W. Johnson, District Engineer, and his assistant, C. E. Palen; Superintendent of Construction Clyde E. Learned, representing the Bureau of Public Roads, worked in conjunction with the officials of the State Highway Department of Colorado. Mr. Learned was on the "firing line" for three years, and, to quote a press clipping, "those who know him and his work will tell you that the Berthoud Pass job is distinctly Learnedian," and that "Learned has built himself in every foot of that superb surface and in every yard of the structure."

Perhaps the greatest tribute to those who carried out this project is contained in a recent announcement that instead of nine miles of highway, as had been agreed upon, 16.6 miles of continuous road over the top of the Pass and down the western approach to the twin bridges over Fraser River, will be turned over to the public. When it is known that the work involved the handling by shovel of over 125,000 yards of common and 154,000 yards of solid rock, some idea of the magnitude of the project may be obtained. Probably more TNT was used in constructing the Ber-



Courtesy Western Highways Builder.

Map, showing the Berthoud Pass Highway route and general location.



Rubble-lined drainage ditch leading to an Armco culvert on the Berthoud Pass Highway.

thoud Pass Highway than on any other road ever built in the State of Colorado. More than 50,000 pounds of this explosive were employed.

The original project agreement of 1920 provided for the construction of slightly over nine miles of road, of which about five miles was on the Empire side of the Pass, the remaining four miles being on the Fraser side.

The day labor construction of 1920 resulted in a large saving to the project, making it possible with the funds remaining to extend the project agreement limits to include the additional pieces of road.

The excavation work was begun from both sides at once. Two three-fourth yards steam shovels began operations in June, 1920, and continued in operation until the excavation was completed.

INTERESTING COST DATA

Permanent camps were established on each side of the Pass and the men were transported to work on trucks when the distance of the camps became too great for walking. The camp equipment was thoroughly up-to-date, and everything possible was done to make the men comfortable and contented. There were shower baths with hot water, ice boxes, good beds and the best food obtainable.

The cost of boarding and lodging the men per season was \$1.62 per day, per man in 1920. This dropped to \$1.35 during 1921. The above amounts included all food and camp supplies, cook's wages, depreciation of cookhouse, tents

and bath house, together with many miscellaneous items.

For the two season's work, the common excavation moved by steam shovel cost about 0.25 per cubic yard. This price included all labor, materials, moving charges and rentals, the rock excavation costing approximately 0.70 per cubic yard.

DRAINAGE FEATURES

As an incentive for increased yardage, and as a means of promoting competition between the shovel crews, a yardage bonus was awarded.

One feature of the construction should not pass unmentioned. On the upper stretches of the western slope, a dry rubble retaining wall serves to guard against landslides. In other sections of the road, where there is danger of erosion at curves and switchbacks, a dry rubble gutter has been constructed for the purpose of conveying surface water to the Armco corrugated iron culverts which run under the road and extend slightly beyond the grade, as shown in an accompanying photograph. Concrete-rubble headwalls prevent erosion at the intake ends of the pipe.

The cost of the Berthoud Pass Highway will total \$220,000 dollars, split between The Forest Service and the State of Colorado. The Forest Service has added \$140,000 to extend the project from the town limits of Empire to the foot of the pass on the eastern side, and the contract has been let for this work.

Irrigation and Drainage

Inexpensive Method of Cleaning Irrigation Ditches

By C. F. FAULK

Special Correspondent for the Highway Magazine

The problem of eliminating vegetation from ditches is successfully solved by the simple method described below.

MAINTENANCE and repair are two items of expense that automatically begin with the completion of almost every type of engineering project, consequently the far-seeing engineer usually plans his construction methods and type of equipment along lines which will tend to keep maintenance and repair costs at the minimum after the project has been completed.

One of the large items of expense in the maintenance of many irrigation systems is the annual cleaning of ditches, canals, flumes and laterals. Where, in addition to the normal deposit of silt and sediment of various kinds, there is added a particularly healthy growth of moss and other vegetation, the problem be-

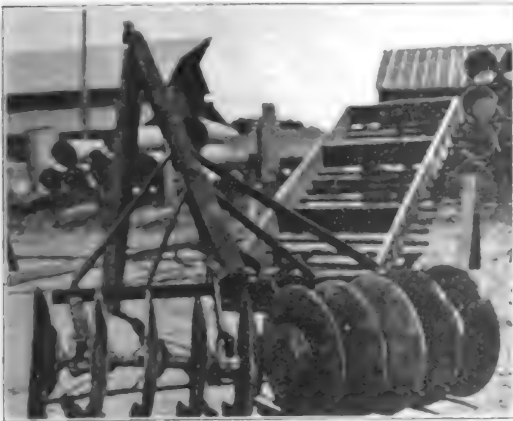


The disc in operation on a weed-filled irrigation canal, Twin Falls, Idaho.

comes especially vexatious and expensive.

J. C. Wheelon, Manager of the Twin Falls Canal Company of Idaho, has employed a method of cleaning earth ditches which has worked successfully for several years.

The keen interest and discussion which greeted an article read by Mr. Wheelon on this subject during the last annual convention of the Idaho Irrigation Congress, disclosed the fact that a great many irrigators of long experience were unfamiliar with the very effective and inexpensive method of cleaning earth



The eight-bladed disc used for cleaning irrigation ditches, as described in the accompanying article.



A huge flume of Armco ingot iron supported by a steel substructure on concrete piers at Ordway, Colorado. This flume, which has a capacity of 1,000 feet a second, is employed by the Twin Lakes Reservoir and Canal Company.

waterways as discussed by Mr. Wheelon.

It might be stated in passing that the Twin Falls Project waters more than 200,000 acres of land so that it can be easily seen the following method has been tried out under a wide variety of conditions.

An ordinary agricultural steel disc harrow forms the main part of the equipment. Due to the soft nature of the ground in and around earth irrigation ditches, it has been found expedient to depend upon horses rather than tractors for power.

In the accompanying photographs the method of operation is shown. The great quantity of vegetation which accumulates each year can be judged from the photograph showing the disc in operation.

In most of the laterals an ordinary eight blade disc will do very effective work. In the very large laterals and main canals Mr. Wheelon has used a 10 or 12 blade machine.

The action of the discs cut loose and stir up the vegetation and sediment which is picked up and carried down stream by the flow of water.

On the Cover

A GLIMPSE of the wonderland of the Northwest is shown in the cover design of this issue of Highway Magazine. It is a typical scene along the Columbia River Highway where good roads and the lure of the great outdoors combine to make this section a tourists' paradise.

•••••

Cost of Tree Planting in California

ABOUT 8,000 trees have recently been planted along the state highways in California, distributed through six counties. A large number of varieties of trees are used, selection being made on advice of the forestry board to suit local soil and climatic conditions. Of 2,920 trees planted in Yolo County, using nursery stock furnished free by the forestry board at its nursery, the total cost in place was 42 cents per tree. The maintenance cost varies from \$50 per annum per mile in the valley sections to over \$300 per annum per mile in the desert, according to a bulletin issued by the state highway commission.

Drainage and Flood Problems Solved by Automatic Drainage Gates

How an Arizona city uses a river for unique construction, prevents back flow in

TAKEN separately drainage and flood control are comparatively simple problems from the engineer's standpoint and each can be handled very effectively if the other is not involved.

Where it is necessary, however, to take care of both drainage and flood control on the same project ordinary methods are apt to fail at the very time when the necessity for drainage and the control of flood water becomes acute.

A rather unusual situation of this type exists in the city of Clifton, Arizona. Clifton lies in a narrow mountain valley on the banks of a river which in ordinary times carries but little water. This river, however, is subject to sudden and dangerous rises, caused by heavy rains that sometimes amount almost to cloudbursts in the surrounding hills.

Heavy masonry levees have been built along the river bank to prevent the inundation of the city during times of high water. Through this masonry levee run several culverts which carry off the



One of the 48-inch Calco Automatic Drainage Gates installed by the city of Clifton, Arizona.



A general view of the river front, Clifton, Ariz., showing the automatic drainage gates attached to Armco culvert pipes as described in the accompanying article.

drainage water of the city into the river. The outlets of these culverts are several feet above ordinary water levels, and at such times serve as ordinary drainage structures.

To prevent the river water from backing up in the culverts and flooding the city streets and cellars when the river is in flood, Calco automatic drainage gates have been fitted to the outer ends of these culvert pipes.

These drainage gates, which work on double hinges and are very sensitive to the slightest water pressure on either side of the gate, close tightly when the river rises to the flood stage and seal each culvert, making it a component part of the levee holding back the river from the city.

The photographs on the preceding page illustrate the river bed formation and the levee construction in the face of which can be seen the Calco Gates attached to the protruding culverts.



One of the many Armco flumes now in use on the great irrigated areas of the West.



This Armco flume is used for carrying oil across an irrigation canal at Bakersfield, Cal. It is in perfect condition after seven years' service.

Indianapolis Patches With Old Asphalt

INDIANAPOLIS this year is utilizing old sheet asphalt for making patches. The following details regarding the methods, which are not new, but are being used for the first time in the Indiana capital this season, have been supplied by J. L. Elliott, city civil engineer:

"The old material when removed from the street, if still in 'live' condition—that is, containing enough oil—is placed in a suitable kettle, after having been broken up, and boiled in just enough water to soften to a point where it may be used. The mixture is boiled long enough to drive off all the water, which sometimes requires only one-half to three-quarters of an hour. The remaining plastic mass is tamped back in the patch after the base and sides of the old pavement have been properly painted.

"Some of the patches made this winter have ironed out until at the present time it is hard to distinguish them from the original street. With the present method we are employing I have not recommended this type of work for more than small patch work, but believe that with a little development it will be possible to do a great deal of the asphalt patching by this method, and thus leave the present hot asphalt plant free to do larger work."



You would accept a certified check

WHEN you buy a stove, a washing machine, a refrigerator or other household article, and it is stamped with the maker's name *and in addition has the Armco triangle*, you know it is as good as a signed, certified check.

The Armco triangle appears only on articles of full value, of more than ordinary merit. Manufacturers couldn't afford to use "Armco" Ingot Iron in cheap articles.

This pure iron resists rust. Because of its especially prepared surface it takes a coat of enameling with a rich gloss that is beautiful in appearance, easy to keep clean, and which has no tendency to crack or chip. Galvanizing holds to "Armco" Ingot Iron—or it is more true to say that the galvanizing and the pure iron base become as one.

Whenever you buy a culvert or other article made of iron, be sure to specify goods bearing the Armco trade-mark. It is certifying our signature to the "check."

Look for this Blue and Gold Armco Label on Washing Machines, Stoves, Ranges, Refrigerators, Enamel Table Tops, and other household and commercial utilities. It carries with it the assurance of the quality and solid worth of the sheet metal parts of articles that bear it.



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In California



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In New Hampshire

Installed 1907



In Service Since 1909

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The HIGHWAY MAGAZINE



January
1923

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The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

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The Ohio Corrugated Culvert Co.

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The Boardman Co.

Oregon, Portland
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Texas, Dallas
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The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIII

JANUARY, 1923

No. 12



A novel means of transportation, devised by an English lighthouse keeper of Yorkshire. He is seen sailing to the town of Kilnsea for provisions. With a good wind, his "craft" will go 30 miles an hour.



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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

A Thought for the New Year

THE calendar heralds another New Year. Several million editorials are on the press calling attention to what 1923 holds in store for the world. In spite of all that has been written or may be written, the year 1923, or any other year for that matter, holds just one thing in store for us—the opportunity to work!

We don't claim originality for this idea, in fact it is about as old as the first eviction notice, which, according to a very ancient and honored authority, brought about the necessity for work. We do claim, however, that it is one of the most important ideas in life.

Man has developed to his present state and finds his highest expression in work, and the men who have accomplished the great things in life, both for themselves and for others, have found joy in their work. They have not felt that they were serving a sentence, but rather that they were enjoying an opportunity.

Lipling has never ceased to preach the gospel of work. It recurs in some form in almost everything, prose or poetry, that he has written. Work is the salvation of man, and even the galley-slave finds his reward in the work itself:

By the brand upon my shoulders, by the gall
of clinging steel,
By the welt the whips have left me, by the
scars that never heal;
By eyes grown old with staring through the
sunwash on the brine,
I am paid in full for service—would that service
still were mine!
It may be that Fate will give me life and leave
to row once more—
Set some strong man free for fighting as I
take awhile his oar.
But today I leave the galley. Shall I curse her
service then?
God be thanked—whate'er comes after, I have
lived and toiled with Men!

To the Road Builders of America,
Greetings and the joy of greater work.

Lincoln Highway Has 'Bus Line in Iowa

SIGNIFICANT of the rapid development of the Lincoln Highway in Iowa is the establishment of daily omnibus service between Boone and Carroll through Jefferson Counties in Iowa.



A recently completed Federal Aid road in Cherry County, Nebraska.



Aerial Photography in Highway Building

By HADDON C. ADAMS

Assistant Highway Engineer, Illinois State Highway Commission

The engineer is always on the lookout for methods and means of building more expediently, more perfectly, and more economically. For this reason, it is not surprising to learn of the many projects which have been materially aided by aerial photography—its proven value in solving the problems of city planning and traffic regulation; of its extensive use in mapping large areas where the scale used is about one inch to the mile. Here is a discussion of aerial photography applied to highway building.

LET us consider, very briefly, the advantages and the limitations of aerial photography for the highway engineer. We realize, of course, that aerial photography can never supercede the present system of ground survey for actual building operations; but this is no reason why we should mentally add a corollary to the effect that, where ground surveys are to be made, aerial photography would not be economically advantageous.

Before the location of a highway is decided upon, a preliminary reconnaissance has to be made. An airplane equipped with camera and gear can, in one day, take photographs of several hundred miles of existing roads, tracks, and possible relocations, with strips of adjacent land on either side, each a mile or more wide; and these views may easily be printed the same day. These pictures can then be made into a mosaic. The cost would be negligible compared with the total cost of the completed highway.

For the purpose of a preliminary highway reconnaissance, with an experienced pilot as photographer, very little correction will be needed. The information

which such a mosaic or photographic map contains is infinite. It shows us at a glance, what detours we can make use of; what condition our present roads are in; the nature of the areas they serve; the exact location, nature and degree of danger of all grade crossings—with the possibilities of alternatives; the proximity of railways for the supply of material and plant; road intersections; bends; probable considerations for "right of way"; general natural drainage conditions, and also an idea of the grades. We see, too, where future developments are likely to be made.

These points, incorporated, are seen all at the same time; one is not forgotten while another is being considered, and undue stress is not bestowed on any one consideration—all receive their right proportion. One may feel certain that, in the not very distant future, all reconnaissances of any magnitude; those of remote areas, or of areas difficult of access, will be made by photographs from airplanes.

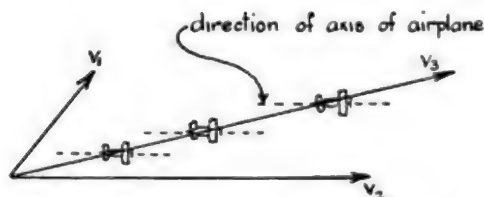
The writer has taken many pictures from a height of fourteen to fifteen thou-



An airplane view of a city, showing location of streets and parks. Photographic records of this kind are valuable in city planning.

sand feet, which have shown up in wonderful detail. Sheaves of wheat can easily be recognized in fields, hedges show up plainly by reason of their shadowy side, railways, embankments, cuttings, all have some distinguishing feature which betrays them to the camera's eye. From this height several square miles are covered by each exposure. As we descend to lesser altitudes, the detail recorded is more perfect.

If we assume an area of, say, four square miles for each exposure, and allow for half of this to be duplicated by overlap, an area of one hundred square miles could be covered by fifty plates. With the automatic devices of today, each picture could have recorded



Diag. 1. V_1 represents vel. of wind
 V_2 represents vel. of airplane relative to air
 V_3 represents vel. of airplane over the ground.

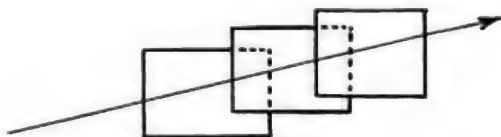
on it the height at which it was taken, the time, the northerly direction, together with an indication that the airplane was, or was not, in a horizontal plane at the instant of exposure.

This knowledge will all be useful if corrections have to be applied later. The orientation can be done rapidly by anyone after a little practice; for even if the photographs are not kept in order, or are not numbered serially, they can soon be located on any map showing roads, or if there is no map they can be fitted together by the overlap. If the north point is not shown, the direction of the shadows, time of exposure being approximately known, confirms the compass points.

Photographs taken at from five to twelve thousand feet, on a clear day, near noon when the shadows are shortest and so are least likely to obscure the ground, are quite satisfactory for highway reconnaissance work. It is obvious that the length of road covered will be directly proportional to the height at which the airplane flies, while the area covered will be directly proportional to the square of the altitude.

A MECHANICAL PROCESS

By reason of the mechanical operations used today, the "personal factor" is largely removed. The pilot takes up his machine, and examines the route, until he has attained the altitude at which the photographs are to be taken. By this time he has learned the strength and direction of the wind, and knows just how to fly his machine in order to



Diag. 2, showing how the mosaic will be formed from the overlapping photographs - conditions of flight as in diag. 1.

These two diagrams will help the aerial photographer in making highway surveys.

keep it over the strip of land which is to be photographed. This will be more or less easy to an experienced pilot. The direction in which the machine moves, and the speed at which it covers the ground, will be given by the vector sum of the airplane and wind velocities. (Diagrams 1 and 2.)

The pilot knows, from the height at which he is flying, just how much of the ground beneath him will show up in the photograph. The machine must be kept in a horizontal position longitudinally and laterally—that is, neither alternating height nor banking.

The plates may be exposed automatically at regular intervals of time if the resultant velocity relative to the ground has been accurately gauged beforehand; or the pilot can expose them as he likes, by pulling a control wire. An automatic device, worked by a small wind motor, changes the plate in a few seconds.

If the photographs are required to be taken at different altitudes, pictures should not be taken immediately upon the correct height being reached, as the altimeter lags slightly in recording the changed altitude. If there are base lines on the ground, these will give the scale, without a record having been kept of the height at which the plate was exposed.

If a mosaic is printed, corrections will probably be applied so that all photographs are on the same scale. The accuracy will be such as would be obtained from the best "survey" when plotted to this same scale—that is, for pictures taken about four thousand feet or over. There will be no chance of "abrupt" errors, or of missing a station, and one correction will be sufficient for the whole picture. There will be no danger of important points having been omitted, for we have a complete replica of the route, with no room for two opinions in the interpretation.

When the final route is decided upon, the survey party can see what the ground is like, before they start on the survey, and what they are able to learn will expedite their work in sundry ways.



Roads through a farming country photographed from a height of 14,000 feet. The picture was taken at 5 P. M. The dark patch is a forest. The light and dark squares are cultivated fields.

To imagine that the mosaic has served its full purpose, would be very short-sighted reckoning. A permanent record is now available of all the area covered. Multiple are the uses this mosaic will serve, if accessible to those requiring it. Maps, far more accurate than present "Post Office Maps," can easily and rapidly be constructed from it, simply by tracing off a mosaic of the required scale. Indeed, the cost of production will be required, many times over, by the many services rendered.

Aerial photography for reconnaissance purposes is economically advantageous at the present time, and will be more and more so as it becomes more extensively used. If the highway engineer is convinced that it is to the advantage of the public, who, of course, pay for the roads directly or indirectly, wherever the location—then it becomes his duty to promote the use of aerial photography in highway engineering.



HIGHWAY MAGAZINE PHOTO

A dangerous underpass east of Waverly, New York, protected by warning signs.

Devices to Eliminate Danger on Underpass Curves

Unique methods employed in widely separated sections of the country to prevent automobile accidents at the underpass.

STATE highway departments are co-operating with the railroads to lessen the danger to traffic where sharp curves occur at underpasses. Illustrated on this page are two underpasses—one in Texas and one in New York—which have some interesting safety-first features.

Above is shown an underpass six miles east of Waverly, New York, on the New York State Highway. At this point the road crosses under the tracks of the Erie Railroad in a double curve with up and down grade on both sides of the underpass.

The striking black and white sign with its warning has been placed on both approaches and there are numerous "Death Curve" warning signs erected by automobile clubs and chambers of commerce at various points along the road. A white line in the center of the pavement serves to keep the motorist on his side of the road.

Another photo shows an interesting device used under the tracks of a trans-continental railroad at Weimer, Texas. Concrete curbs, one in the center and

one at each side, are being built to divide traffic at this underpass. The curves or abutments will be 200 feet in length at the underpass. The middle curve will be 80 inches high and will divide the road in two lanes, each 10 feet wide. It is thought, by the use of this device, that the motorist will "keep to the right."



Makes the motorist "keep to the right."

How To Compute Culvert Loads

An Interview with DEAN ANSON MARSTON of the Department of Engineering, Iowa State College, by LOUIS A. GRAHAM, M.E.

In this article, the second of a series of interviews, Dean Marston shows how he developed the formula for finding what load a culvert must carry, under various fills, ditch conditions, kinds of earth, etc. This formula was the first ever developed for finding culvert loads from embankment, and is based largely on the long-continued experiments described by Dean Marston in the first interview which appeared in Highway Magazine for December.

IF we wanted to make a rough calculation of the load that a culvert must support, the first tendency would be to calculate the weight of the column of earth directly above the culvert, and set this down as the load that the culvert must carry. Unfortunately, this computation would be far from exact, and would usually err on the wrong side, giving a value far less than the actual load.

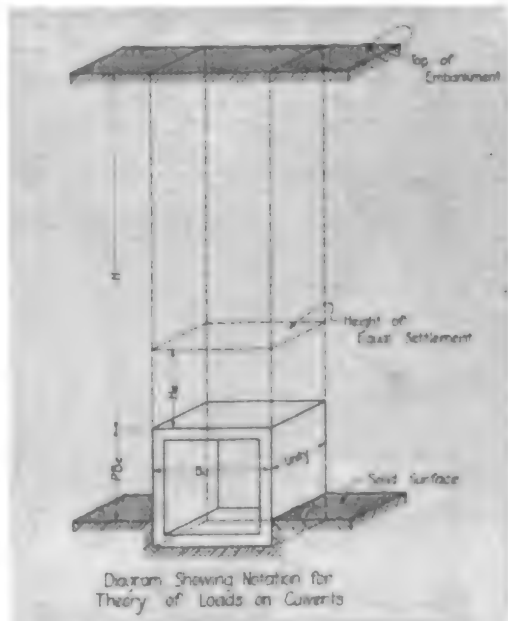
This was brought out clearly in the experiments we made in 1919-20 (as described in a previous article). We found that the load on the culvert was often as great as twice the weight of the earth above it. For instance, on January 5, 1920, when our test culvert was under 20 feet of loam fill weighing 96 pounds per cubic foot, measurement of the weight borne by the 3-foot 3-inch diameter culvert showed a load of 12,257 pounds per lineal foot. This is actually 1.92 times the weight of the column of material immediately above the culvert. (Actual weight = $3.25 \times 1 \times 20 \times 96 = 6,240$ pounds.)

It should be noted that this load of 12,257 pounds was obtained under the usual condition of culverts in fill, the culvert being only slightly embedded in the solid earth, with the bulk of its circumference projecting above the original soil level into the newly placed fill. (We call this "Projection Condition.") At the other extreme were the loads observed in our experiments with a pipe placed at the bottom of a trench dug in the solid earth. (This is called "Ditch Condition" and obtains chiefly in sub-soil drainage practice.) Culverts tested in this way were shown to carry in many cases only one-fifth of the load found for projection condition; in fact, a load less than the weight of earth

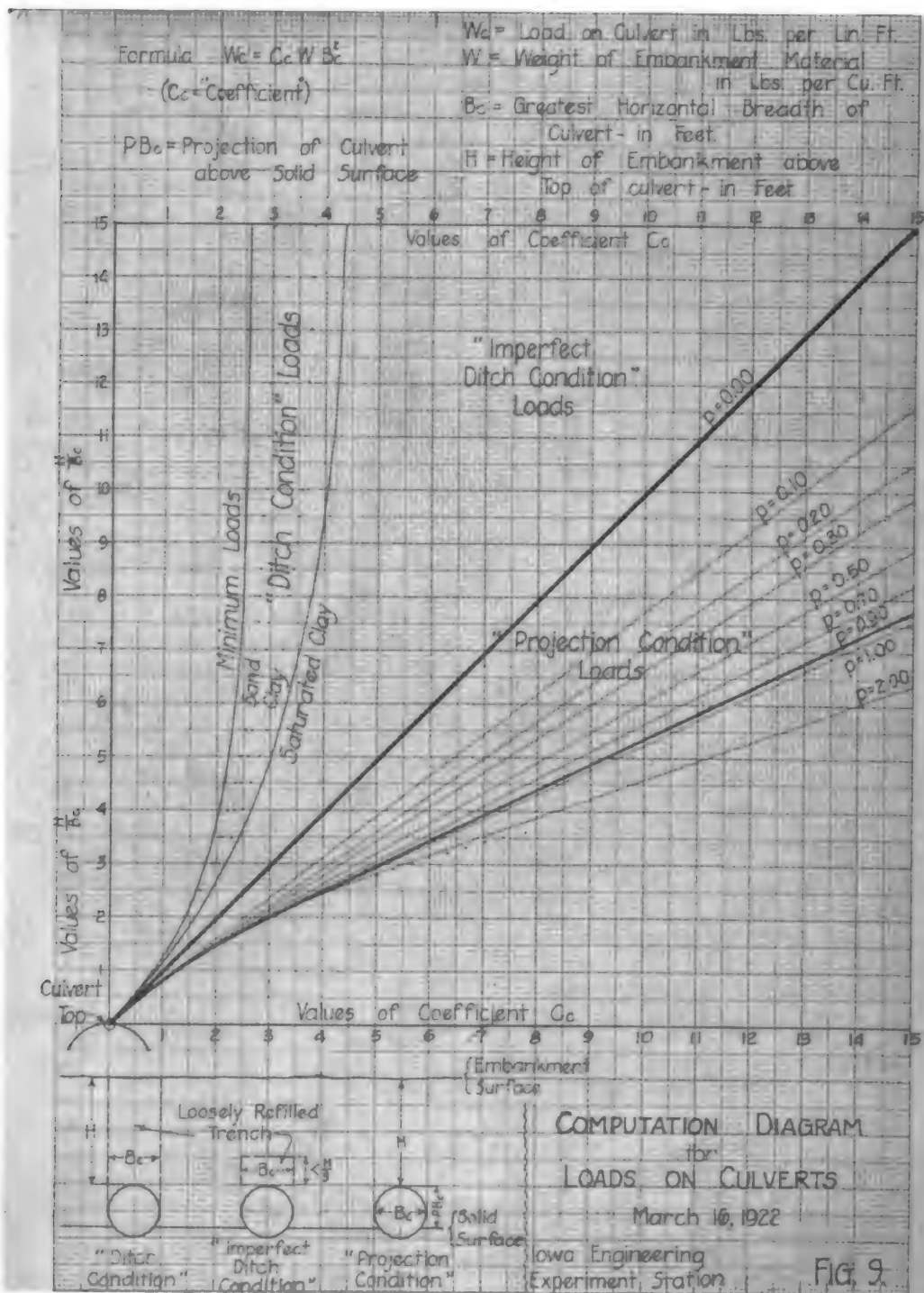
above it. Incidentally, it must be emphasized that often it is impracticable—and undesirable—to attain a perfect "Ditch Condition" in culvert practice.

From the above it is evident that the method of embedding the culvert in the ground is an important factor in determining the load due to weight of embankment, and one that must be taken into account in any formula that is to be used successfully in the calculation of these loads.

To develop the formula, it is essential to understand something of the basic reasons behind these results. First, let us consider the "Projection Condition." Here the bulk of the culvert extends above the natural surface of the earth, so that the layer of fill directly above the culvert naturally rests on it and is



(FIGURE 1)



(FIGURE 2)

This chart gives a ready means for computing the value of the coefficient to be used in the formula for finding the load on the culvert for any diameter, height of embankment, kind of soil, and manner of embedding.

supported by it. But in addition, there is a definite tendency for the earth on each side of the column directly above the culvert to slip by the earth right above the culvert, and this introduces a vertical friction, which also must be borne by the culvert.

This increase in vertical load, due to the earth at the side of the culvert, may be more clearly understood by studying Fig. 1. The internal friction along the vertical planes tangent to each side of the culvert drags down on the column of materials directly over the culvert, and therefore increases the vertical pressure within the column, which in turn increases the load on the culvert itself.

This condition, however, continues only up to a certain height, which is explained as follows:

Settlement of earth is of course proportional to the pressure causing it. The increased vertical pressure on the culvert comes from the greater settlement of earth on the side of the culvert, and this settlement of earth is due to the stress, multiplied by the height of earth itself. Although the stress in the earth at the side of the culvert is less than that above it, the height of the earth at the side is, of course, greater than the height of earth above the culvert, and this causes the greater settlement. As we add further layers of earth above the culvert we reach a point where the *pressure of the earth above the culvert, times the height of embankment above the culvert, becomes equal to the pressure of the earth at the side of the culvert, times the height of earth at the side of the culvert.*

When this condition is reached, the addition of another layer of earth will cause equal settlement above and at the side of the culvert. This height is called "height of equal settlement."

Now, let us see what occurs in "Ditch Condition." Here the culvert has been let down into a ditch so that the only loose earth is that immediately above the culvert. For a 20-foot fill this loose earth per lineal foot of culvert, using 96-pound material, would weigh 6,240 pounds. But even this weight is not all carried by the culvert in this case. A part is absorbed by the frictional resistance of the firm shoulders, for instead



Part of the apparatus used in the test from which the load formulae were derived. Showing the beams that transmitted the loads from the culvert sections to the scales.

of the shoulders settling and dragging down on the culvert, they are of solid earth, so that they tend to prevent the column of loose fill in the ditch from exerting its full weight on the culvert. In fact, as the height of fill is increased, a point is reached where the firm shoulders finally absorb practically the entire additional weight of fill, so that there is little increase in the pressure on the culvert from increases in fill beyond the height of ten times the diameter of the culvert.

To allow mathematically for the frictional effect in these various conditions requires an involved formula, which has been greatly simplified for practical use by the introduction of a constant. The values of this constant have been computed and charted to cover all usual needs, and are shown in Figure 2. With the use of this constant the load on culverts from fill may be expressed mathematically as

$$W_c = C_c w B_c^2$$

where

W_c is load on culvert in pounds per lineal foot.

(*We shall be glad to supply interested readers with the complete working out of this formula).

w is weight of embankment materials in pounds per cubic foot.

C_C is a constant to be determined for each condition, (values for practical computation given in Fig. 2).

B_C is the greatest horizontal breadth of the culvert in feet.

Sample Calculations: B =Dia. of Culvert=3 feet.

DITCH CONDITION

H =Height of embankment=21 feet.

From curve at extreme left of the diagram read

$H/B_C = 7$ and the coefficient = 2.45.

The load on the culvert per lineal foot (W_C) using 100 lb. embankment material is $W_C = 2.45 (C_C) \times 100 (w) \times 9 (B^2) = 2205$ pounds.

PROJECTION CONDITION

Culvert projects 70 per cent of its diameter above solid surface.

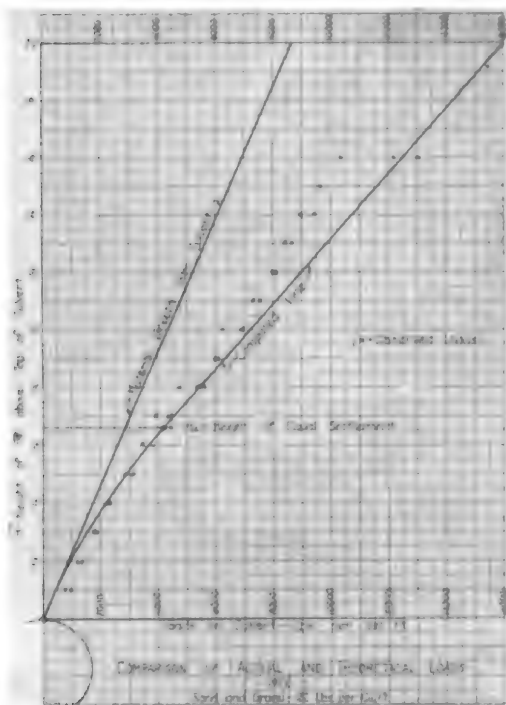
Read from curve coefficient 12.65.

Then for the 100 pound material

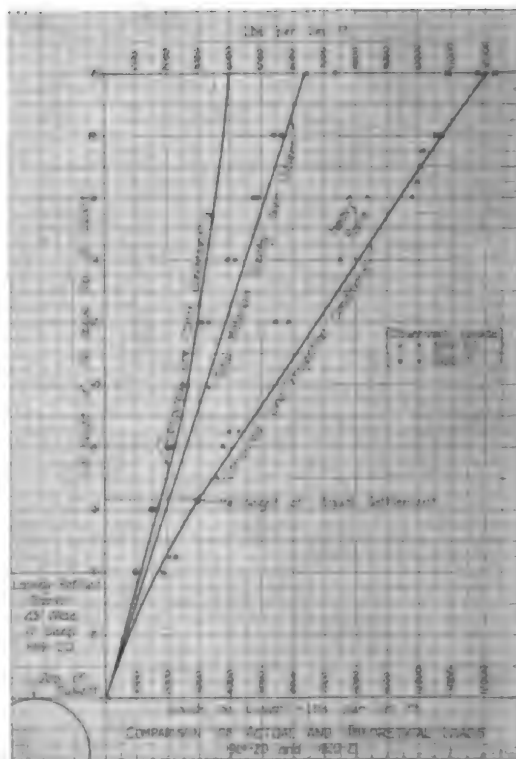
$W_C = 12.65 (C_C) \times 100 (w) \times 9 (B^2) = 11,385$, approximately 5 times the value found for "Ditch Condition."

Between these two extremes the load for "Imperfect Ditch Condition" may be determined.

This condition, as described in the last



(FIGURE 3)



(FIGURE 4)

article, was obtained in the experiments by artificially compacting the soil to a height of four feet and then digging a ditch in this compacted soil down to the culvert, re-filling the ditch loosely and then continuing the fill in the usual way. This gave loads about 50 per cent of "Projection Condition."

It must be emphasized that these formulas are derived from an entirely new theory of loads on culverts. The real test of the reliability of this new theory is comparison of the theoretical loads, with the loads actually weighed in carefully conducted experiments. Such comparisons have been made and are given in Figures 3 and 4, in which the various experiments described in our first article are plotted in comparison with graphs obtained from the formulae. *The correspondence of actual to theoretical loads is wonderfully exact.*

We have not considered so far in the discussion the effect of traffic load superimposed above the embankment. This will be discussed in our next article, which will deal also with the application of these formulae to a suggested set of strength specifications for culverts.

Road Construction Under the Alaska Commission

By COLONEL JAMES GORDON STEESE, M. Am. Soc. C. E.

Colonel Steese is President of the Alaska Road Commission, District Engineer for Rivers and Harbors; Consulting Engineer, 16th Lighthouse District; Consulting Engineer for the Territory; and War Department Representative on the Inter-Departmental Alaska Council.



A caterpillar tractor equipped with special snow plow is hauling a train of heavily-loaded sleds over a frozen river bed in Alaska.

THE provisions of the Federal Aid Road Acts are not applicable to the Territories of Alaska and Hawaii. In Alaska, the construction, repair and maintenance of roads, bridges, trails and related works is entrusted by law to the Alaska Road Commission. In addition to the writer, Major John C. Gotwals is Chief Engineer, and Captain A. H. Bond, Secretary-Treasurer of the Commission. Prior to its organization in 1905, there were in the whole of the Territory less than a dozen miles of what might be called wagon road, with a few hundred miles of pioneer trail, mostly constructed by expeditions under the War Department.

In 1919, the Territorial Legislature appropriated \$400,000 for roads, for two years, and in 1921, \$240,000.

During its eighteen years of existence, the Commission has expended about \$8,000,000 upon a system of 6,290 miles of roads and trails, reaching from open-all-the-year south coast ports to all inhabited parts of the Territory.

The total expenditures during the past fiscal year for roads and trails amounted to \$683,247.68, of which \$236,251.91 was for construction, and \$446,995.77 for maintenance. Work was performed upon 5,990 miles of the system. The Alaska

Road Commission has never professed to build hard-surfaced roads, nor would any such construction be justified in view of the great extent of country to be covered with very meager resources. In many isolated localities, the erection of a cableway and cage across a glacial stream, or the setting of stakes across the



The heavy black lines represent the Alaskan railways and highways described in the accompanying article.



Eleven dogs hauling five Armco culverts for installation on the Talkeetna-Cache Creek project. These pipes are part of two carloads recently used on this road. The entire shipment was economically transported by dog teams.

open tundra, is a matter of life and death to the inhabitants.

The most important project of the Commission is the Valdez-Circle Military Road, or Richardson Highway, extending from Valdez, an open-all-the-year south coast port, to Circle, on the Upper Yukon River, a distance of 531 miles, or about the distance from Boston to Richmond, or from Vancouver to Banff. This road is now passable for automobiles throughout except for 79 miles between Chatanika and Miller House, on the portage between the Yukon and Tanana Rivers. Construction upon this section is actively under way. The 371 miles between Valdez and Fairbanks was passable for dog teams in 1909, for a light horse-drawn wagon in 1911, and in 1913, the first automobile made the through overland trip which involves crossing the Coast or Chugach Range through Thompson Pass at an elevation of 2,750 feet, and the main Rock Mountains, or Alaskan Range, through Isabelle Pass, at an elevation of 3,300 feet.

Of even more importance than the wagon roads to the economic life of the Interior, are the winter sled roads and trails over which all mail, except express, and personnel, are handled. Even heavy freight can be handled by bob-sled in the winter time more economically than by

truck in the summer time. Twenty-five cents per pound is a not uncommon charge for handling provisions and miscellaneous supplies over unimproved trails, and a community considers itself lucky when the through rate from the railroad, or river landing, is reduced to less than ten cents. Data collected by the Commission indicate that transportation charges upon freight actually passing over its roads and trails have been reduced over \$2,000,000 annually, due to the improved facilities provided.

The Talkeetna-Cache Creek project affords a striking example of this. For years the Commission had maintained a crude pack trail into this district and the production in 1919 and 1920 was only about \$140,000 in gold. In 1920, the Commission expended \$75,000 on a 42-mile route to the Government Railroad, opening up the entire mileage for sled traffic, and is continuing its improvement to road standard. The following winter 500 tons went into the district by bob-sled at a saving of three cents per pound, or \$30,000, over the old rate. As a result, several hydraulic plants are being installed and a hydroelectric plant is being built to furnish power for a dredge. Last winter the freight amounted to 800 tons, and the saving \$48,000.

The most important new work included in the Ten Year Program, is the provision of road and trail feeders to the Government Railroad. To date, Congress has declined to authorize special relief for the railroad and adheres to its original development policy.

However, using its existing system as a nucleus, the Alaska Road Commission has to date provided 43 feeders to the Government Railroad, covering, in fact, all known areas of possible development. Not all of these routes are completed, but the Ten Year Program contemplates their completion as well as the completion of additional projects that may develop during the next ten years.

Now that the Government Railroad is completed, a very interesting circular tour may be taken, as shown on the accompanying map; namely, in over the Government Railroad and out over the Richardson Highway by automobile.

Irrigation and Drainage



Metal Flume Has Perfect Maintenance Record on Oregon Project

How the cost of repairs on wooden flume is causing replacement with flume of Armco ingot iron on Simas ranch in Monument, Oregon.

A TYPICAL example of the elimination of maintenance cost on an irrigation project is illustrated in the case of the Simas ranch in Monument, Oregon.

Joseph M. Simas, together with three other farmers, brought a tract of land totalling 350 acres under irrigation three years ago. The approximate cost of in-



A view of the same flume, which carries irrigation water around the hillside on the Simas ranch.



A view of the Armco flume which is rendering perfect service on the Simas ranch in Monument, Oregon, as described in the accompanying article.

water, the crop yield has increased 400 per cent.

In the matter of maintenance, several hundred feet of Armco ingot iron flume was installed, together with a quantity of wooden flume. According to Mr. Simas, not a dollar has been spent on the maintenance of the Armco flume, while the wooden flume has been the direct cause of considerable loss due to leakage, and has necessitated constant watching and frequent repair. Where leaks develop the water washes out the footings under the underpinnings, in some cases causing the entire failure of the flume and several weeks delay in getting water to the growing crops.

Because of the high maintenance cost and the lowering of the crop yield, due to the failure of wooden flume, Mr. Simas is replacing the wooden flume as fast as possible with Armco flume.

The laborer is worthy of his hire—also the engineer.

stalling the irrigation system was \$140 per acre. Rye and wheat had been grown on the land before the system was installed, but the greatest yield was about a ton of rye to the acre. With



This Armco flume, which is 208 feet long, was installed on the Cary-Stedman ranch, near East Gridley, California. It parallels the trains of the Sacramento-Northern Railroad.

Insuring an Adequate Water Supply

A few facts and figures and an interesting flume installation in California.

DURING the last 20 years there has been a great advance in the knowledge of the principles of dry land farming, or "dry farming" as it is more generally termed. In spite of the increase in crop yields under the most favorable dry farming conditions, farmers are turning more and more to irrigation wherever it is at all feasible to get water onto the land.

While the cost of bringing land under irrigation runs anywhere from \$60 to \$150 per acre, yet the increase in production and the almost total elimination of the weather factor, makes irrigation highly profitable.

Given an adequate water supply, the expense incurred in building canals and ditches and installing flumes is generally repaid by the increase in land values alone.

The accompanying photographs show an inexpensive type of flume installation used in carrying water across a river bed. This particular installation is on the Cary-Stedman Ranch, about a mile north of East Gridley, California, paral-

lel to the right of way of the Sacramento Northern Railroad.

Two hundred and eight feet of No. 60 Armco ingot iron flume were used with a concrete intake. The construction work was done by H. L. Barlow, Engineer. The photograph is through the courtesy of E. Mackissick, of the Sutter Butte Canal Company.

Public Roads Bureau Plans Rural Engineering Research

IN the future the rural engineering division of the U. S. Bureau of Public Roads will concentrate its work on research problems. Heretofore the division has found it difficult to relinquish its wide activities in extension work. The point now has been reached, it is believed, where the states and local agencies are sufficiently acquainted with the work to carry forward the educational part of the program.

Increased research is planned on such problems as the flow of water in drainage ditches; drainage by pumping, and the effects of alkali waters on concrete.

Gigantic Irrigation Project Under Way

*Horse Heaven Irrigation District in Washington Will Water
340,000 Acres of Land When Completed.*

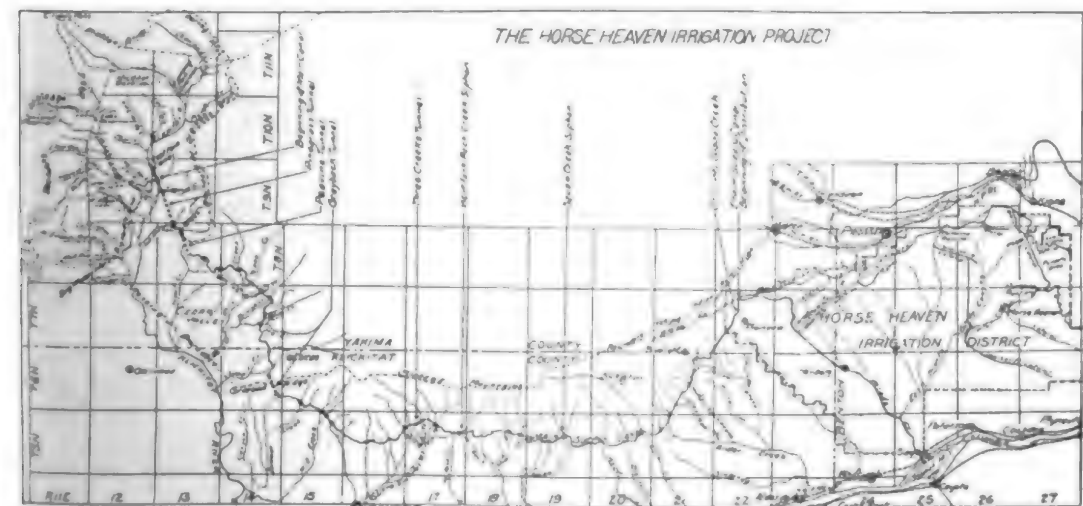
ONE of the most gigantic feats in the history of irrigation is now under way in the State of Washington. A \$32,000,000 bond issue has been voted by the landowners and the Superior Court has validated the enterprise. March 1, 1925, will see the completion of the Horse Heaven Irrigation Project, if the present schedule of construction is maintained.

The Horse Heaven plateau is a tract of semi-arid land lying between the Yakima and Columbia rivers in South Central Washington, and in all contains about a million acres. It is planned to water 340,000 acres of this land. The Irrigation District proper lies in Kittitas, Yakima and Benton Counties.

DESCRIPTION OF THE PROJECT

Water will be carried a distance of 112 miles from the various branches of the Klickitat River and collected by means of the Big Muddy, West Fork and East Fork canals. The Main Supply canal will begin at the junction of the West and East Forks. This canal will traverse the east side of the Klickitat Canyon, Cedar Valley, and will then

follow along the south slope of the Simcoe mountains until the Glade Canyon is reached. A drop of 570 feet will mark the end of the Supply Canal. The distribution of water to the lands commences on the east side of Glade Creek Canyon. The main distribution canal will convey the water as close to the top of Horse Heaven hills as is possible. Another drop of 308 feet will be introduced near Ward Gap. This, with the fall in Glade Canyon, will produce during the greater part of the year a theoretical maximum of 100,000 horse power of electrical energy. As the need arises, the district will provide storage facilities in the form of reservoirs situated on the headwaters of the Klickitat. As the demand for more water increases the water from neighboring streams along the canal route will be diverted to the needy lands. The general plans for the canal will follow the survey laid out in 1920. Some changes proposed by Albert L. Smith, engineer, will reduce the cost from \$32,000,000 to \$28,250,000, making a per acre cost of \$880. This does not take into account any reduction of the \$4,000,000 estimated as an



This map shows the location of the Horse Heaven irrigation project and its relation to the other irrigated districts in that section of the State of Washington.

interest charge during the construction period.

It requires more knowledge than a superficial glance can give one to recognize the potential possibilities of the Horse Heaven Irrigation District, but all who are familiar with it are a unit in declaring that it will ultimately be developed into one of the richest sections of the entire Northwest. The territory under discussion lies between the Yakima and Columbia Rivers, the greater part of it being in the southern portion of Benton County, with smaller sections in Yakima and Klickitat Counties. At the summit of the hills which rise from the Yakima River the land lies at an elevation of from 1,500 to 2,000 feet. A gradual slope to the southwest through immense fields of wheat and rye, intersected by undeveloped land covered with sagebrush and bunchgrass, lowers the altitude from 700 to 1,000 feet. Few, if any, trees break the line of vision which stretches for miles on either side and farm buildings, owing to the size of the tracts each landowner must work, are necessarily far apart.

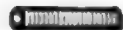
WILL INCREASE CROPS

This plateau stands in direct contrast to the irrigated valley whose checkered fields stretch northward to the Rattlesnake hills and westward to the Cascades, from which the snow-covered peaks of Mt. Adams and Rainier rise as eternal guards over the lower countries. Yet those who are best acquainted with conditions are looking to the dry highlands, rather than the fruitful lowlands for the maximum production of the future. The Horse Heaven country needs only the water, which in the last few years has been brought in abundance to a great part of the valley, to transform it into one of the greatest farming sections of the West.

The soil, which consists of lake bed silt, volcanic ash (decomposed basaltic

rock), and humus of decayed vegetation, varies in depth from 5 feet at the western extremity to 75 and 100 feet on the east. Owing to its firmness it is well-adapted to irrigation. In some respects climatic conditions on the plateau are more favorable for growing crops than in the surrounding districts. The extremes of temperature are less marked and the crops are less subject to killing spring and early frosts so that the growing season is longer.

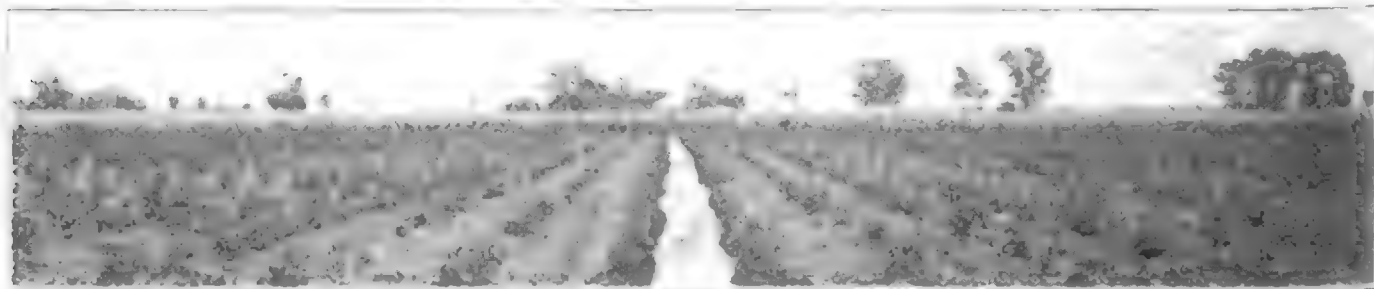
Under conditions of irrigation, production on the Hill will not be confined as formerly, to grains, but will be extended to include all crops familiar to Central Washington. It has been proven that this land is capable of yielding fruit and vegetables comparable to the best produced in the state. Future Horse Heaven, however, must not be made to yield in spite of climatic drawbacks, but with the aid of irrigation will rise to the highest degree of fruitfulness.



Drainage of Irrigated Lands

CONSTRUCTION of drainage works for irrigated lands represents about 12 per cent of the expenditures from the Reclamation Fund during the past few years, according to figures given by J. L. Burkholder, drainage engineer, in the Reclamation Record.

This work represents an annual expenditure of about \$1,000,000 and has aggregated \$8,000,000. It includes 889 miles of drainage ditches, 183 miles of pipe drains, several pumping stations, and also the investigations for present and future installations. The work completed is estimated to have reclaimed and protected from seepage about 370,000 acres of irrigable land, and there remain about 125,000 acres which are damaged to some extent by seepage. These drainage works are located on seventeen projects in thirteen states.



ARMCO



Culverts and Washing Machines

Did it ever occur to you that a washing machine has the same excuse for rusting that a culvert has? Both are subject to a succession of wet spells and dry spells and the alkali contained in soap and washing powders is duplicated by the alkali of the soil.

A number of leading washing machine manufacturers have adopted ARMCO Ingot Iron for the sheet metal parts of their machines, because its remarkable purity and evenness of texture make it highly rust resistant.

This fact should be significant to the highway engineer or constructor who wants rust-resisting culverts. May we send you the proof that ARMCO Ingot Iron *does* resist rust?



The American Rolling Mill Co.
Middletown, Ohio

Pleasure Cars had Solid Tires

when the first photograph
was taken in 1910



Photograph
taken in 1910



Photograph
taken in 1922

Styles in cars and tires
had changed by 1922

but the **ARMCO CULVERT**
remains unchanged with no trace of 12 years usage



The HIGHWAY MAGAZINE



**"The Road
Past Your Door"**

What does it mean
to your children?

**Cash Prizes for
the Best Answers**

See Page 3

**February
1923**

**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
Ingot) Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Calgary, Vancouver, Vernon

The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIV

FEBRUARY, 1923

No. 1



The Storm King Highway, the costliest highway in the United States, shortens the distance between New York City and points in northern and western New York by several miles. It is one of the most popular tourist routes from Broadway to Niagara Falls. See article page 11.



FEBRUARY, 1923

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Association

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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

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Uniform Distribution of Irriga- tion Water, By Prof. G. E. P. Smith.....	Page 15

Boost the Good Roads Movement in Your High Schools

THE school boy of today is the merchant, the farmer, the banker, the doctor—the TAX PAYER of tomorrow. His vote will determine the condition of the highways which will serve your community. His "good roads education" should not be neglected.

The traffic on our highways has doubled, and in some cases trebled, during the last three years. Millions are being spent for road construction and maintenance, and many millions more will be used to fill the mud holes and lay the surfaces for better and wider highways during the next decade.

The good roads movement is as vital today as any other single economic movement affecting the nation as a whole. It touches every social, commercial, educational and religious activity in which we are interested, and is a vital factor in our everyday life.

The editors of *Highway Magazine* believe that every high school student should appreciate the value of good roads—should know what the good roads movement means—and should realize how the condition of the highways affects his community as well as his nation.

Many of the thousands of readers of

Highway Magazine have sons and daughters attending high school, or friends and relatives who are teaching in the high schools. To them we call attention to the prize story contest open to high school students, which is announced in this issue of *Highway Magazine*.

It is suggested that teachers of English in the high schools make "The Road Past Your Door"—as suggested in the story contest—the subject for a theme or essay to be prepared as an exercise in English composition, and that the best stories on this subject be entered in the contest.

In thinking and writing about good roads, the student will necessarily study the question and come to a fuller realization of the value of better highways. Newspapers, chamber of commerce and civic clubs should call this story contest to the attention of their readers and members who have boys and girls of high school age, and urge these young men and women to enter the contest.

As announced on the opposite page, all stories must be submitted before midnight of March 15th, to be considered by the judges. The winners will be notified by telegraph before midnight, March 31st.

FIFTY DOLLARS IN CASH PRIZES To High School Students

Tell the Story of the "Road Past Your Door."

EVERY high school student in the United States or Canada has an opportunity to win any one of three cash prizes offered by the Editors of *Highway Magazine* for the three best stories about "The Road Past Your Door." The awards—\$25, \$15, and \$10 for the first, second and third best stories submitted—will be made on March 31st, when the winners will be notified by telegraph. The contest will close at midnight of March 15th, and the winning story will be published in the June issue of *Highway Magazine*.

The subject, "The Road Past Your Door," has been selected because it can be dealt with in a thousand different ways, and because it is the most important road to you. For example, if the road past your door is good or poor, there is a reason why it has, or has not, been improved; what is the reason? How does the condition of this road affect you, your farm, your town or city? If the road has been improved, how was the work done? By the people themselves in your community, or by a contractor or by your town, county or state? Has this improvement helped you, your family, your neighbors, or your town? How? Was some unique construction plan employed in building or improving this road? How is it maintained? How is it drained?

On the other hand, if the road is unimproved, how does it hinder social or

commercial, or religious, or educational progress in your community?

These are just a few of the many subjects suggested by the "Road Past Your Door." You can probably think of many more. Select one and write—don't bother

about "fine writing;" what we want are facts, clearly stated, with the names of the road builders or maintainers and the exact location of the highway.

Don't worry about the length of the story—it may be long or short—but it

must be accurate as to details. Don't over-state or under-state—tell the facts in an interesting way.

The inclusion of a few photographs of the road you describe will be considered favorably by the judges, but pictures are not necessary to win first prize.

In submitting the manuscript, give the name of the high school you are attending, as well as the name of its principal, as this contest is only open to high school students.

The Judges in the story contest will be announced in the March issue of *Highway Magazine*. They will include representative men who have made a study of road economics and the relation of this subject to our social and industrial problems. The Editors of *Highway Magazine* will also be represented among the Judges.

**How your son or daughter
can win a cash prize by
writing the story of the
most important road to you
and your children — "The
Road Past Your Door."**



North Carolina Highway Hunches



LABORERS, working on North Carolina State Project No. 125, known as the Rocky Mount-Tarboro Road, discovered a new use for old automobile tires while hard surfacing the highway with asphaltic concrete.

Spreading and raking the hot asphaltic mixture as it comes from the trucks is a warm job and the men protected their feet by cutting sections of old rubber tire cas-

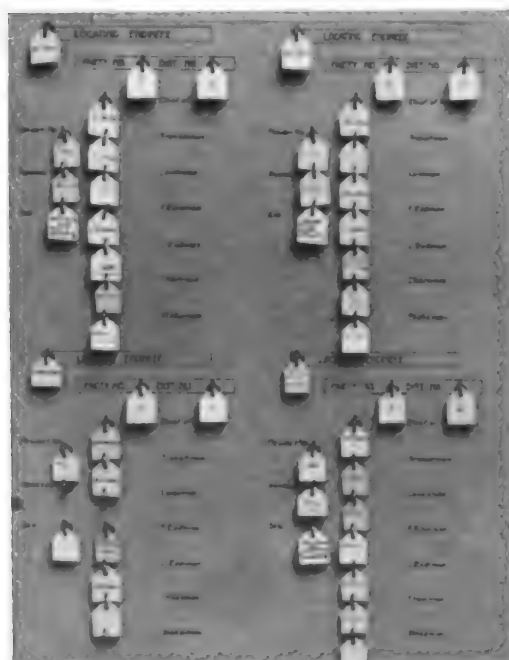
ings and tying to their shoes as pictured above.

The progress chart at the left (which is reproduced in part) was devised by O. B. Bestor, Chief Locating Engineer, of the North Carolina State Highway Commission for use in the Locating Department.

This chart provides a flexible method of keeping an up-to-date record for ready reference of the movement of parties or individuals from project to project; change of address and change of supervising Locating Engineer; the interchange of motor cars and equipment between parties and the transfer of employees from one party to another.

Besides the information given on the front of the tags, there is also shown on the reverse side, the salaries of the employees. The tags are reversed when an employee is on vacation. A glance at the diagram indicates which parties are short-handed, whether this condition is temporary or whether a vacancy needs to be filled.

If a man is transferred from one party to another, or if he is promoted from one position to another, it is only necessary to hang the tag bearing his name on the proper hook. If a motor truck is brought in for repairs and later assigned to another party, that tag is transferred in the same manner. If an entire party is transferred from the supervision of one Locating Engineer to that of another it is only necessary to change the tag bearing the engineer's name, rather than the tags comprising the names of the entire party.



A small section of the chart used by the Locating Department of the North Carolina State Highway Commission, described in the above article.

A Study of Traffic on the State Highways of Wisconsin

By N. M. ISABELLA
Assistant Maintenance Engineer, Wisconsin Highway Commission

In the following article, the author presents some interesting facts and figures obtained by a study of traffic during a four-year period—1919 to 1922—and suggests the importance of traffic counts in planning highways for the future.

ONE of the main factors which help highway officials to determine the type of road to be built is the knowledge of the amount and character of the traffic using that highway. Since 1918 Wisconsin has maintained a system of State Trunk Highways by what is commonly known as the patrol system and the State Highway Commission has, during this period, made a study of the traffic on the various State Trunk Highways. Representative points on all main highways have been established, there being at least one point or traffic station in each of the 71 counties. Traffic counts are taken at these points on several days during the travel season. In order to get fair and average counts, they are taken on both maximum and minimum days. Sundays and holidays usually produce the maximum counts, while week days usually bring lower counts. By averaging the maximum and minimum, a fair daily average is arrived at.

One of the interesting features brought out by these traffic counts is the gradual increase in the percentage of foreign or out-of-state cars, and the decrease in the number of horse drawn vehicles.

Through traffic counts taken each season, a thorough study can be made of the future requirements when new construction is contemplated.

Many of the states are at present confronted with the task of furnishing proper highways for traffic, which has grown to such tremendous proportions that the present highways cannot adequately and economically carry the burden. It, therefore, behooves those in charge of highway construction and maintenance to study the subject of traffic very thoroughly before making recommendations for future improvements.

The Wisconsin Highway Commission

Form 144

TRAFFIC CENSUS GREEN LAKE COUNTY

Taken SEPT 20 1922 From 6 A. M. To 11 P. M.

On Pinckney-Green Lake Road, S. T. H. 533 Mile No. 70

HOUR	MOTOR VEHICLES									
	Wisconsin Cars				Foreign Cars	Motor Trucks		Motor-cycles	Horse Drawn Vehicles	
						Light	Heavy			
6:00	||||	||||	||		|		||	||||		|
7:00	||||	||||	|||		||		|	||		||
8:00	||||	||||	||||	|			||	|||		|
9:00	||||	||||	||||	||||	||		|	||||	|	||
9:45	||||	||								
10:30	||||	||||	||||	|||	||		||||	||		||
11:00	||||	||||	||||	||||	|		|||	||	|	||
11:50	||||	||||	||							
12:00	||||	||||	||||	||	||		|	||		|
1:00	||||	||||	||||	|||	|||					
2:00	||||	||||	||||	||||	||		||	|||	|	|
3:00	||||	||||	||||	||||	|||		|	||		|
3:32	||||	||||	|||							
4:00	||||	||||	||||	||||	|					|
4:25	||||	||||	|||							
5:00	||||	||||	||||	||||						
5:40	||||	||||	|							
6:00	||||	||||	||||	||||	||||	||||	||	|	||	
6:20	||||	||||	||||	||||	|||		|			
6:50	||||	||								
7:00	||||	||||	||||	||||	|					
7:37	||||	||||	||||	|						
8:00	||||	||||	||||	||||						
8:40	||||	||								
9:00	||||	||||	||||	||||						
9:31	||||	||||	||||	||						
10:00	||||	||||								
	135	125	99	67						
Total					426	29	23	27	4	19

Weather Conditions: Cloudy all day
NOTE: Trucks Over Two Ton Capacity Class as Heavy. Report Cars Not Displaying Proper License Plates on Reverse Side of Sheet.

Fig. 1.
Chart used by Wisconsin State Highway Department in taking daily traffic census.

has designed a simple form, as shown in Fig. No. 1, upon which traffic counts are made. Fig. No. 1 shows one sheet of an actual count made during the season of 1922. It will be noted that the first column is for the hour the count is taken. The second heading is for Wisconsin cars. The third heading is for cars from other states. All counts are started at 6:00 A. M. and continued till 11:00 P. M.

The Highway Magazine

In some instances when conditions warrant counts are taken for the entire 24 hours. When one line is filled, the recorder drops a line and enters the exact time in the hour column. In this way it can be seen when each type of vehicle

1919 COUNTS

DATE	NO OF TRAFFIC STATIONS	WISCONSIN CARS	FOREIGN CARS	MOTOR TRUCKS	MOTOR CYCLES	HORSE DRAWN VEHICLES	TOTALS
8-24	51	30631	4770	920	1366	1834	47541
8-27	33	13678	1496	876	480	2011	18541
9-17	33	10089	1221	920	541	1901	14642
9-21	31	12247	1585	303	532	1197	15864
10-15	37	9989	753	1059	426	2849	15078
10-19	33	18437	1530	583	657	1272	22419
TOTAL	220	103061	11357	4661	4002	11064	134145
NO. PER STA		468	52	21	18	50	609
% OF TOTAL		76.7	8.8	3.4	2.9	8.2	100.0

Fig. 3

1920 COUNTS

DATE	NO OF TRAFFIC STATIONS	WISCONSIN CARS	FOREIGN CARS	MOTOR TRUCKS	MOTOR CYCLES	HORSE DRAWN VEHICLES	TOTAL
7-25	55	52242	7542	1082	1248	1682	63766
8-11	40	23530	3466	1853	694	2221	31764
8-22	50	44992	5475	925	1260	1586	54238
9-6	46	38259	6322	1622	1069	2656	49928
9-22	43	21762	2366	1799	488	2660	29015
TOTAL	242	180785	25171	7251	4759	10805	228771
NO. PER STA		748	104	30	20	45	947
% OF TOTAL		79.0	11.0	3.1	2.2	4.7	100.0

Fig. 4

1921 COUNTS

DATE	NO OF TRAFFIC STATIONS	WISCONSIN CARS	FOREIGN CARS	MOTOR TRUCKS	MOTOR CYCLES	HORSE DRAWN VEHICLES	TOTAL
7-4	62	87258	15306	2732	1498	1640	108434
7-20	62	41714	5803	3711	669	2424	54523
8-10	65	57511	6245	3586	421	3182	50745
8-21	60	69516	10947	2170	1103	1862	85398
9-8	66	76763	15439	3042	1184	2835	98512
9-18	43	37468	2773	2066	282	2071	44660
9-21	17	8198	198	902	102	389	10389
TOTAL	375	357928	57312	18009	5259	14153	453661
NO. PER STA		955	153	48	14	38	1208
% OF TOTAL		79.1	12.7	4.0	1.1	3.1	100.0

Fig. 5

1922 COUNTS

DATE	NO OF TRAFFIC STATIONS	WISCONSIN CARS	FOREIGN CARS	MOTOR TRUCKS	MOTOR CYCLES	HORSE DRAWN VEHICLES	TOTAL
6-21	60	38912	4412	5453	512	2594	51963
7-4	62	99192	14821	3126	1119	1281	119535
7-19	67	48413	7792	5315	459	2463	64432
7-30	66	90336	11581	2968	990	1210	107485
8-9	63	47048	8269	5286	551	2405	63559
8-20	63	91755	15058	2697	1047	1207	109764
9-4	63	79510	15990	4158	936	2235	102829
9-20	62	39292	4160	4583	450	2647	51132
TOTAL	508	534458	80543	33586	6070	16042	670699
NO. PER STA		1050	160	66	12	32	1320
% OF TOTAL		79.5	12.1	5.0	0.9	2.5	100.0

Fig. 6

Total traffic census for four successive years in Wisconsin, tabulated in simple and comprehensive form.

begins moving on the highway and at what period it is at maximum. Motor trucks, which are shown in the fourth heading, are divided into two classes—light and heavy; everything over two ton capacity is considered heavy. The fifth heading is for motorcycles, and the sixth horse-drawn vehicles. It is very likely that for future traffic counts, this form will be revised to show an additional column for the recording of passenger motor busses.

Counts such as shown in Fig. 1 are taken at each of the designated points in the 71 counties. After each day's count is completed, they are immediately sent in to the main office and are tabulated on one large sheet. After all counts have been taken for the season, they are totaled and summarized as shown in Figs. 3, 4, 5, and 6. In 1919, 1920 and 1921 traffic counts were taken on six different days of each season. In 1922 counts were taken on eight different days. For convenience in studying the character and amount of traffic by years, a summary is prepared of the counts made each year. These are shown in Figs. 3, 4, 5, and 6. It is interesting to note from these summaries that the total number of vehicles per station for each count in 1919 was 609. In 1920 there was a considerable increase and the total number of vehicles per station reached 947. There was a further increase in 1921, there being 1,208 per station. In 1922 the average per station reached 1,320 vehicles. It can be seen from these figures that the traffic on Wisconsin highways has more than doubled since 1919. By a thorough study of the situation one can readily see that the traffic has increased at a greater speed than the construction or improvement of the highways during the same period.

A further study of these yearly summaries shows a considerable increase in the number of out-of-state cars and a very noticeable decrease in the number of horse-drawn vehicles. Wisconsin is a summer playground for a great many people coming from neighboring states.

There are sections in the state where the out-of-state cars outnumber the local cars. This is especially true in the regions where there are numerous lakes. The out-of-state traffic is becoming a very

important factor in Wisconsin's highway development. Special counts have been made in order to ascertain the number of states represented in Wisconsin during the summer months. Inasmuch as Madison is one of the main intake cities for tourist traffic, a traffic census for foreign cars is taken on each Thursday of the last three weeks in August. Practically all foreign cars going through Madison visit the Capitol Square and for this reason the census is taken at this place. In order that each car be counted but once, the actual license number and the state is recorded, so that in checking at the end of the day duplicates are discarded. The count is started at 7:00 A. M. and continued until 8:00 P. M. The first count, which shows a daily average of 216 foreign cars was made in August, 1919. There were 16 states represented in this count. In 1920 the daily average was 369 and 20 states represented. In 1922 the daily average was 446 and 23 states represented. The tabulations in Fig. 2 show the counts for the four years on Thurs-



This information booth is one of many which are popularizing Wisconsin's highways with the out-of-state motorist.

day of the third week in August. It is quite interesting to note the number of states represented and the number of cars from each state.

Several of the neighboring states with their fertile prairie land have comparatively little in the line of natural scenery and summer vacation grounds to attract the average tourist. For this reason it is noticeable that the cars from these states predominate. While there was a considerable increase in 1922 over previous years, there would have been a still larger percentage of foreign cars from the south central and central west states had this summer been warm instead of unusually cool. The weather conditions seem to have quite an effect on tourist traffic. After a continued spell of warm weather one can see tourist cars headed for the northern lake region in increasing numbers. This applies also to our own people in the southern part of the state who go north as soon as warm weather begins.

Much can be said on the subject of traffic, but the writer has only touched on some of the high spots. He has endeavored to give the reader a rough idea of the character and amount of traffic on Wisconsin State Highways, and an idea of how traffic on the various highways may be studied.

In the writer's opinion, there have been many cases in the past few years where highway officials have not given proper consideration to the character and probable development of traffic in their design of new highways.

FOREIGN TRAFFIC COUNT ON CAPITOL SQUARE MADISON, WIS.				
STATE	NO CARS ON 8-24-22 26 states	NO CARS ON 8-18-21 20 states	NO CARS ON 8-19-20 19 states	NO CARS ON 8-21-19 16 states
Illinois	362	270	251	191
Iowa	47	29	56	13
Minnesota	31	27	12	19
Indiana	28	16	15	10
Michigan	23	10	10	8
Missouri	22	7	4	5
Ohio	9	2	12	3
Pennsylvania	6	2	2	1
South Dakota	5	4	2	1
North Dakota	3		1	
Nebraska	3	3	1	1
Kentucky	2			
New York	2	1	1	
Washington	2			
California	2	4		
Kansas	2	3	1	1
Rhode Island	1		1	1
Colorado	1		1	
Montana	1		1	
North Carolina	1		1	
Oklahoma		4		
Wyoming	1			1
Connecticut	1			
Texas	1	2	1	1
Idaho	1			
Dist of Columbia	1			
Oregon		1		
Massachusetts		1	1	1
Louisiana		1		
Alabama		1		
South Carolina			1	
West Virginia				
Maryland				1
Florida				1
New Jersey				
TOTALS	559	389	380	260

Fig 2

Note the steady yearly increase in foreign traffic in Wisconsin.

How to Specify Strength of a Culvert

An interview with DEAN ANSON MARSTON of the Department of Engineering,
Iowa State College, by LOUIS A. GRAHAM, M. E.

WE have already shown how to compute the load on a culvert, due to the weight of embankment material, for any depth of fill, kind of earth, dimensions of culvert, and condition of surrounding soil. In our discussion so far, we have not taken into account the loading effect of the traffic on the road.

This is figured independently of the embankment load, and the two figures—traffic load and embankment load—are added to give the total load on the culvert.

In 1920 we made a series of experiments on traffic loading. The first experiments were made with the embankment at a level of 12 feet above the top of the culvert, and we used a truck loaded to a total of 10 ton weight, placed in various positions on the surface of the fill. The loads it imposed on each 2-foot section of the culvert were noted. This process was repeated at lower levels, at

one foot intervals, from 11 down to 3 feet. We found by repeated trials that the load on any one 2-foot section of the culvert was a maximum when one rear wheel of the truck was directly over it, as shown in figure No. 1*. On this figure the observed values are marked as crosses and give in each case, the load that was measured on the most heavily loaded 2-foot section, when the rear truck wheel was directly above that section. The smooth curve is drawn from the theoretical formula for this loading, described below.

This curve is extremely interesting, because it shows how rapidly the traffic load on the culvert decreases for a fill greater than 4 feet. In fact, the curve indicates that for deep fills, the effect of traffic in comparison with the embankment load may virtually be disregarded.

We have worked out a formula for these traffic loads, and the theoretical

*See Graph on page 10

This is the third and concluding article in the series of interviews with Dean Anson Marston, of the Department of Engineering, Iowa State College, which embody the first published accounts of the results obtained from a series of tests and experiments on culvert loads covering a period of three years.

The first article, entitled "What is the Load on the Culvert," appeared in the December, 1922, issue of THE HIGHWAY MAGAZINE, and outlined the circumstances which prompted the making of the tests and the manner in which they were conducted, as well as a detailed description of the special apparatus used; the data obtained from tests under "Projection Condition" and "Ditch Condition," together with photographs, diagrams and charts.

The second article, entitled "How to Compute Culvert Loads," which was published in the preceding issue of THE HIGHWAY MAGAZINE, told how Dean Marston developed the first workable formula for finding what load a culvert must carry under varying depths of fill, conditions of embedding, kinds of earth, etc., supplemented with figures, graphic charts and photographs of the methods employed and the results arrived at.

The third article, presented herewith, describes the effect of super-loading, and offers some suggested specifications for the supporting strengths of culvert pipe.

If you have missed either one or both of these important articles, the two previous issues of THE HIGHWAY MAGAZINE containing this original engineering data may be obtained from the publishers.

values (computed from the formula) correspond wonderfully well with the actual values obtained from the experiments. The formula has been made extremely simple by the introduction of a constant, and reads as follows:

$$W_t = C_t \times T$$

Where T = the total concentrated load applied at one point on the surface of an embankment

W_t = the corresponding load directly under T per unit of length transmitted to the top of the culvert.

C_t = a constant depending on the height of embankment above the top of the culvert, and the diameter of the culvert.

We have worked out tables to show the value of C_t for various conditions, and in order to make the computation it is necessary only to select the proper value of C_t , and multiply by the wheel load.

Calculations made for a wide range of conditions bear out the experience of actual practice—that the effect of concentrated surface loads upon the loads transmitted to the top of culverts, is negligible under considerable depths of embankment. For small highway culverts, the depth beyond which concentrated loads may be neglected is approximately 4 feet. This is slightly greater for culverts over 48 inches in diameter, and the limiting height is somewhat greater also for railway culverts than for highway culverts.

By applying the formula for embankment loading, that we discussed in the preceding article, and this formula for super-loading, we can readily find the total load a culvert must carry under any possible conditions of service. (This total excludes only impact loads for which special data are now being obtained.)

As we have already emphasized, the loads to be carried are far greater than most highway and railway engineers have supposed. In fact, where ordinary projection conditions are used—that is to say where a culvert is in a fill and projects for the large part above the natural bed of the earth, the load from embankment alone may amount to twice as much as the weight of the earth to be carried.

The most important conclusion drawn,



View showing entrance to scale room where the loads on the culvert are determined. The 20 foot walls make it possible to test a culvert under any fill up to 20 feet.

both from the tests and from the mathematical considerations (with which the test data are in striking agreement)—is that culverts *have in the past been designed of inadequate strength to carry the load*. Hundreds of failures of culverts, that we ourselves observed in a recent experimental investigation in the State of Iowa, fully bear out this conclusion.

In order to safeguard against recurrence of such failures, and at the same time make available to highway and railway engineers, the results of the experimental work I have described, a movement was set on foot to prepare some temporary specifications that engineers might use for the supporting strength of culvert pipe.

The need for some immediate culvert pipe specifications of this character was presented so strongly to the Joint Culvert Pipe Committee at its meeting in Chicago, November 28, 1921, that it adopted unanimously the following temporary specifications, for use:

1. CLASS "2250 D"—Culvert pipe designed for ordinary highway purposes, up to 12 feet height of embankment.

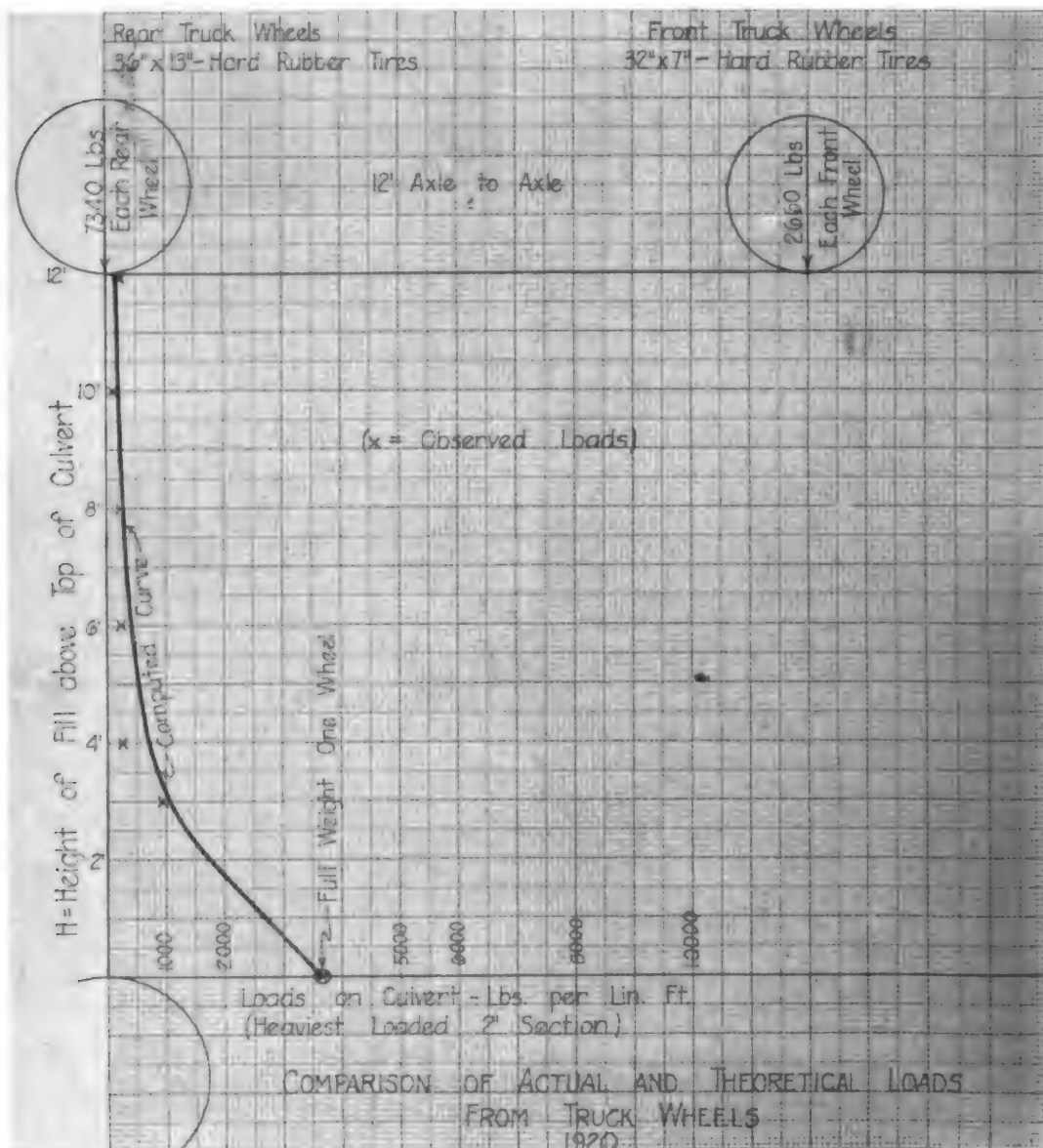
The supporting strength of Class "2250 D" culvert pipe by the "Sand bearing"

test shall be not less than $2250 \times D$, in pounds per linear foot of length of pipe, where "D" is the nominal internal diameter of the pipe in feet.

2. CLASS "3000 D"—Culvert pipe designed for ordinary minimum requirements of railway practice.

The supporting strength of Class "3000 D" culvert pipe by the "Sand Bearing" test shall be at least $3000 \times D$ in pounds per linear foot of length of pipe, where D is the nominal inside diameter of the pipe, in feet.

3. The "sand bearing" test mentioned under heads 1 and 2 above is the same as specified in the Standard Specifications of the American Society for Testing Materials for Drain Tile, Serial Designation: C4 - 21. However, the test may be made by the "three point" bearing method described in the same specifications, in which case, however, the results obtained in the laboratory must be multiplied by 1.50 before being reported as supporting strengths.



(Fig. 1) Data on this graph is described fully on pages eight and nine.

The Costliest Highway in the United States

How the Storm King Highway on the Hudson River has been completed, forty years after the project was first planned. The road is four miles in length and cost the huge sum of \$700,000.

WITH the completion of the Storm King Highway, officially known as the West Point - Cornwall State Highway, in New York State, one of the most difficult engineering problems that ever confronted highway constructionists, has been solved.

The highway, which is only four miles in length, is perhaps one of the most picturesque motor routes in the country.

About forty years ago efforts were made to build a road around Storm King Mt., but failed owing to lack of capital. In 1892 surveys were made and in 1903 a petition was presented to the state for the construction of the road. In 1907 a contract was let for building two miles of the road. The work was stopped by a taxpayer's injunction suit. In 1915 the state called for bids on the road, and the contract was let to John L. Hayes, of Yonkers.

Almost insurmountable obstacles were



The Storm King Highway under construction. Note how the solid granite of the Palisade wall has been blasted out to make a roadbed. Partially completed retaining and guard wall can be seen in the distance.



A fine view of the Palisade country along the Hudson River, showing the scenic beauty which greets the motorist on the Storm King Highway.

encountered by the engineers in making the first survey. Mark W. Nelson, one of the State's highway engineers, was in the first party of surveyors. He recalls that at times the only way of securing data upon which to complete the plans was by lowering men with surveying instruments at the end of a 100-foot rope.

Another novel scheme of arriving at the dimensions was by the shooting of cans of colored paint from a small cannon borrowed from the United States Military Academy at West Point. The cannon would be aimed at a spot on the rocks inaccessible by climbing or other methods, and after the paint had burst and left its imprint the surveyors could work up the necessary figures from it as a starting point.

The first survey was made in the winter time when Storm King Mt., was covered with ice and snow. The surveyors worked all of the time with life belts and ropes. Several accidents happened. Among the engineers injured was Dudley Babcock, of Albany, who was confined to a hospital for several months as a result of a fall.

Contractor Hayes encountered many difficulties in installing his plant on the south side of Storm King. First it was

necessary to transport a five-ton crane over the mountain at an elevation of 1,300 feet. Other equipment had to be taken apart at the railroad station, repacked piece by piece and drawn up the mountainside by mules.

Because of the dangerous character of the work the contractor had great difficulty in hiring men. Laborers demanded extra money for climbing up and down the mountain. Before the Volstead act went into effect one workman demanded that he be supplied daily with six drinks of whiskey during working hours.

The new road is one of the most important in the state. Commercially it will be of great value. It will shorten the highway distance between New York and Albany and will make West Point and Highland Falls more accessible to the residents of the other parts of Orange County.

The road is from 250 to 400 feet above the Hudson River. It is the most expensive highway built in the United States, also the most difficult from an engineering standpoint. The cost is estimated at about \$700,000.

Governors and highway officials of many of the Eastern States attended the opening of the road.

Culvert Headwalls of Petrified Wood

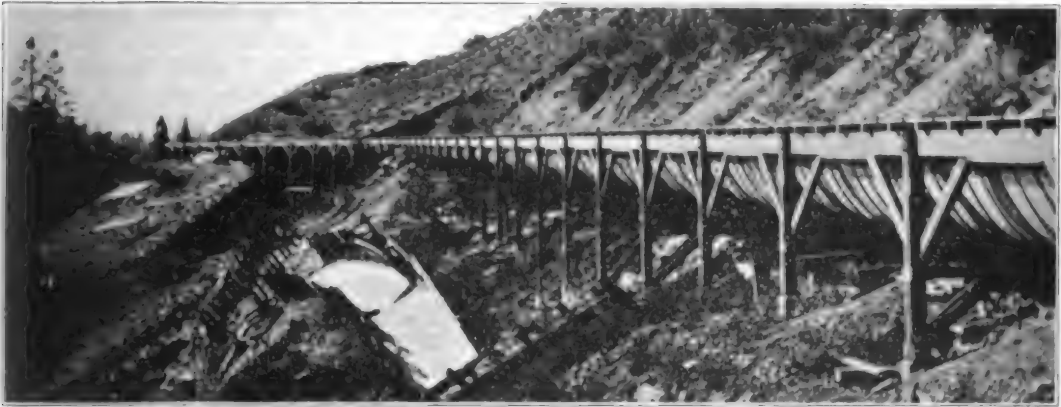


Along the National Old Trails route in the Petrified National Forest near Holbrook, Navajo County, Arizona, contractors have found a new use for the petrified tree trunks in which the region abounds. Chunks of petrified wood make fine culvert headwalls, as shown in the above photographs.

Irrigation and Drainage

The Growth and Possibilities of Irrigation Development

What irrigation has done for the arid lands of the West and the potentialities that lie in future reclamation activities.



Modern irrigation in the arid West necessitates the best equipment in the utilization of water. Leakage of water and consequent erosion of the hillside caused destruction of the wooden flume pictured above, which was replaced with a modern Armco ingot iron flume.

IN the past few years interest in irrigation development has been steadily increasing. Evidence of the rapid growth of irrigation in this country is contained in the fact that the total estimated area of irrigated land in all countries amounts to 100,000,000 acres, while the United States has 15,000,000, mostly the result of only 50 years' development.

Modern irrigation in the United States seems to have had its origin in Utah, where the Mormons introduced the art about 75 years ago. The early settlers of California, Arizona and New Mexico extended the previous practices of the Spaniards and Indians in those states. Following the development in Utah, modern irrigation was taken up in California and Colorado about 20 years later and soon the practice had extended to all the arid states.

In early irrigation operations many

mistakes were made. It was a new venture and many of the engineers were inexperienced in irrigation work. Education was rapid and thorough, however.

Up to the year 1920, the net cost of construction of 25 Federal reclamation projects during the 18 years of Federal reclamation work, amounted to about \$125,000,000. The value of crops grown during the previous year on these projects amounted to \$89,000,000, or 71 per cent of the cost of irrigation works. The area cropped was 1,113,469 acres, and the gross return per acre was \$79.88.

The advantages of irrigation are apparent from the statistical fact that the annual farm census of the Reclamation Service shows the value of products grown on its irrigation projects to be about twice as large per acre as the average yield of unirrigated land in the humid regions. The chief reasons for this preeminence of



The beautiful El Cajon Valley near San Diego, California. This is one of the finest agricultural sections in the West.

irrigated agriculture over non-irrigated agriculture are, in the order of their importance, as follows:

- (a) Ability to apply water at the correct time and in correct quantities.
- (b) Presence of more mineral plant food in the soil because it has not been leached out by the rainfall as in humid regions.
- (c) Greater amount of sunshine during the growing season than in the corresponding latitude of the humid region.

As a rule, greater care is exercised in planting and cultivating the crops that are irrigated and in every way the irrigationist is encouraged to more careful and intensive agriculture because he is in a large measure the architect of his own destiny, being practically independent of rainfall for his moisture, and having in practical control the most important factors bearing on his success.

The state of Oregon alone, is now producing crops on approximately 1,000,000 acres of irrigated land. This area does not include lands for which irrigation systems are constructed, and upon which no crops have as yet been produced. Over sixty irrigation districts have been organized in this state, covering an area of over 1,000,000 acres, less than 500,000 acres of which are irrigated at the present time, leaving approximately 500,000 acres

in well organized projects awaiting reclamation.

There still remain in the far west 20,000,000 acres of arid land susceptible to reclamation. Ultimately this great area will be placed under the ditch. That there is a great need for this added area of productivity is evidenced by statistics compiled by the United States Department of Commerce.

For the single item of sugar, it is estimated that the yearly consumption is approximately 100 pounds per capita. This would require the employment of 5,000,000 acres of soil in the production of sugar beets if our country desires to produce all it consumes of this essential food product. The United States produces one-fourth of the sugar it annually consumes; therefore we could well put to use over 3,500,000 acres of our own land to the production of sugar.

Theodore Roosevelt, after his first trip west while still a young man, always carried a vision of the vast possibilities of the west that could be realized through irrigation. In a chapter of his autobiography devoted to "Natural Resources of the Nation," he said: "The first work I took up when I became President was the work of reclamation." It was his judgment that "reclamation, conservation and proper utilization were all involved in one great plan for the development of our western country."

In the light of our social and economic structure, there is another important manner in which irrigated agriculture stands preeminent, namely, in the development of cooperation. The daily occupation of farmers of the humid regions provides fewer points of outside contact than that of any other part of the population, consequently he has comparatively little opportunity to develop the power to cooperate. This is not true of the irrigation farmer, as he must cooperate with his neighbor and his neighbors' neighbor, such cooperation being enforced by the necessity of community use and operation of the irrigation system. Such cooperation tends strongly to develop community conscience and public spirit, and the character of civilization produced by irrigated agriculture, therefore, has a tendency to create a higher order of citizenship than is the result without it.

Uniform Distribution of Irrigation Water

By G. E. P. SMITH

Professor of Irrigation Engineering, University of Arizona

The following discussion of the uniformity of distribution of irrigation water, which also takes up the necessary slope to be given the land and the head of water required, is digested from a bulletin recently issued by the University of Arizona.

SEVERAL years ago, the writer made some investigations to determine the uniformity of distribution of irrigation water. In one case, on heavy loam, it was found that the average percentage of soil moisture at the head of a land, for six feet depth, was increased from 24.1 to 26.3 per cent by a 4-inch average irrigation, while at the tail end the soil moisture was increased from 15.4 to 18.2 per cent. In another case on sandy loam the soil moisture at the head end was increased from 14.3 to 21.1 per cent and at the tail end from 8.3 to 12.2 per cent. In both cases, therefore, the head end had more soil moisture before irrigating than the tail end had after irrigating—a preposterous condition. Inasmuch as the alfalfa near the foot of each land was making excellent growth, it follows that the head ends of the land were getting unnecessarily large, wasteful amounts of water.

On one of the fields thus tested the

average depth of water applied in 1914 was 108.2 inches. Unquestionably, 50 per cent of the water thus applied sank to the water table and was wasted. Many similar cases have been observed where the quantity of water absorbed at the head ends was found to be excessive and wasteful. When these conditions exist, the remedy is less water more rapidly applied, by means of a larger head, or shorter runs, or steeper slopes.

SLOPE OF LAND AND HEAD OF WATER

The problems of what slope to give the lands and what head of water is best are inter-related, and involve also a discussion of the length and width of lands, and the character of the soil. Any one of these five factors can be taken as a function of the other four factors. The problem is complex and should be solved separately for each crop, and for each locality.

In some communities, the solution is



Proper distribution of water is essential to good crops. Photo shows lateral headgate on Bishop Creek Ditch Company's project, Owens River, California. Lawrence Bodle former Road Superintendent of Inyo County, is in charge.



Armco culverts and headgates used in distribution of water, Bishop Creek project, Owens River, California.

thought to be the grading of the lands level, or on a very slight gradient, which entails an additional expense of \$20 to \$40 per acre. This outlay is of doubtful utility. In the writer's opinion the lands should be graded down the natural slope or approximately so. Surely any lands with slope from 3 to 40 feet per mile and with good soil can be laid out and irrigated without material change in the general direction of the slope.

The other factors, then, can be determined so as to give the most uniform distribution of water. Thus, on light soil with a grade of 20 feet per mile, where a large head of water is available, perhaps the land can be laid out 50 feet wide and 880 feet long. If the head of water is small, as from a No. 5 centrifugal pump, then the lands should be not over 30 feet wide and 440 feet long. If, however, the grade is only 10 feet per mile, the lands,

perhaps, should be 660 feet long for the large head and 330 feet long for the small head.

These values are intended to be suggestive; on shallow soils underlain by caliche the lands can be longer; in some cases lands 1,300 feet long are irrigated successfully. For heavy loams the lands can be considerably longer than for sandy soil, and in general the flatter the grade, the shorter should be the runs and the larger should be the head of water. Heavy, or "hard," soils are found usually on flat slopes, as from 5 to 10 feet per mile. In the latter case, the lands may be as long as $\frac{1}{4}$ mile, but they should be narrow, say 36 feet wide, so that a small unit head can be made to cover the width uniformly.

UNIFORMITY OF DISTRIBUTION

The final adjustment to obtain an even distribution should be made by varying the head of water in each land. This adjustment should be made last because it is the easiest to make. Recently an irrigator near Mesa, Ariz., complained that the stand of alfalfa was better in the lower part of his field than in the upper part. He wished to regrade the field so as to reduce the fall. But the remedy was much simpler than that. His head of water delivered by the Reclamation Service was 300 miner's inches. By changing his order and obtaining 275 miner's inches he would get a uniform irrigation and uniform crop. Many irrigators have difficulty in getting the water across their land. They require a larger unit head. They should order more water, or concentrate it in fewer lands, or if this cannot be done without increasing the unit head to a point where it will erode the soil, then the length of run should be reduced.

Uniformity of distribution is possible, but requires thought and skill and probably some investigation on the part of the irrigator. Every irrigator should use a soil auger or a shovel to ascertain the penetration of the water and the condition of the soil, at least to 5 feet in depth, before and after an irrigation. This should be done near the head end, near the center, and near the lower end of one or of several lands.

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FOR GAS AND ELECTRIC WELDING

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A gaping crack or a break in the iron! Five to six thousand degrees of heat blazed into the crack until the iron melts! Then the welding metal flows into the open space, makes a perfect union with the broken iron, and the break is healed.

Welding is not like sticking together two pieces of wood with glue. In welding, the iron that is used to fill the crack must become an inseparable part of the iron that is broken (or of the two parts that are to be joined.)

"Armco" Ingot Iron makes a perfect union. Impurities that might prevent this have been removed from "Armco" Ingot Iron, permitting the tiny molecules to hug one another closely.

The same basic purity which makes "Armco" Ingot Iron perfect for welding, insures resistance to rust.

Culverts made of "Armco" Ingot Iron are guaranteed 99.84 per cent pure, and will resist corrosion under the most adverse conditions.

Thousands of "Armco" culverts, corrugated to add strength, and covered with a two ounce coating of galvanizing per square foot of metal to give even greater resistance to corrosion, are in perfect condition today after a decade of service.

Write for Needed Information



The American Rolling Mill Company

MIDDLETOWN, OHIO



THE road surface above and the culvert below have widely different requirements. Rigid materials that make a satisfactory road surface will sometimes shatter under the stresses to which a culvert is often subject.

Rigid Above

The rigid road surface is favored by many engineers because it offers smooth travel to traffic, and resists the abrasive action of heavily loaded wheels.

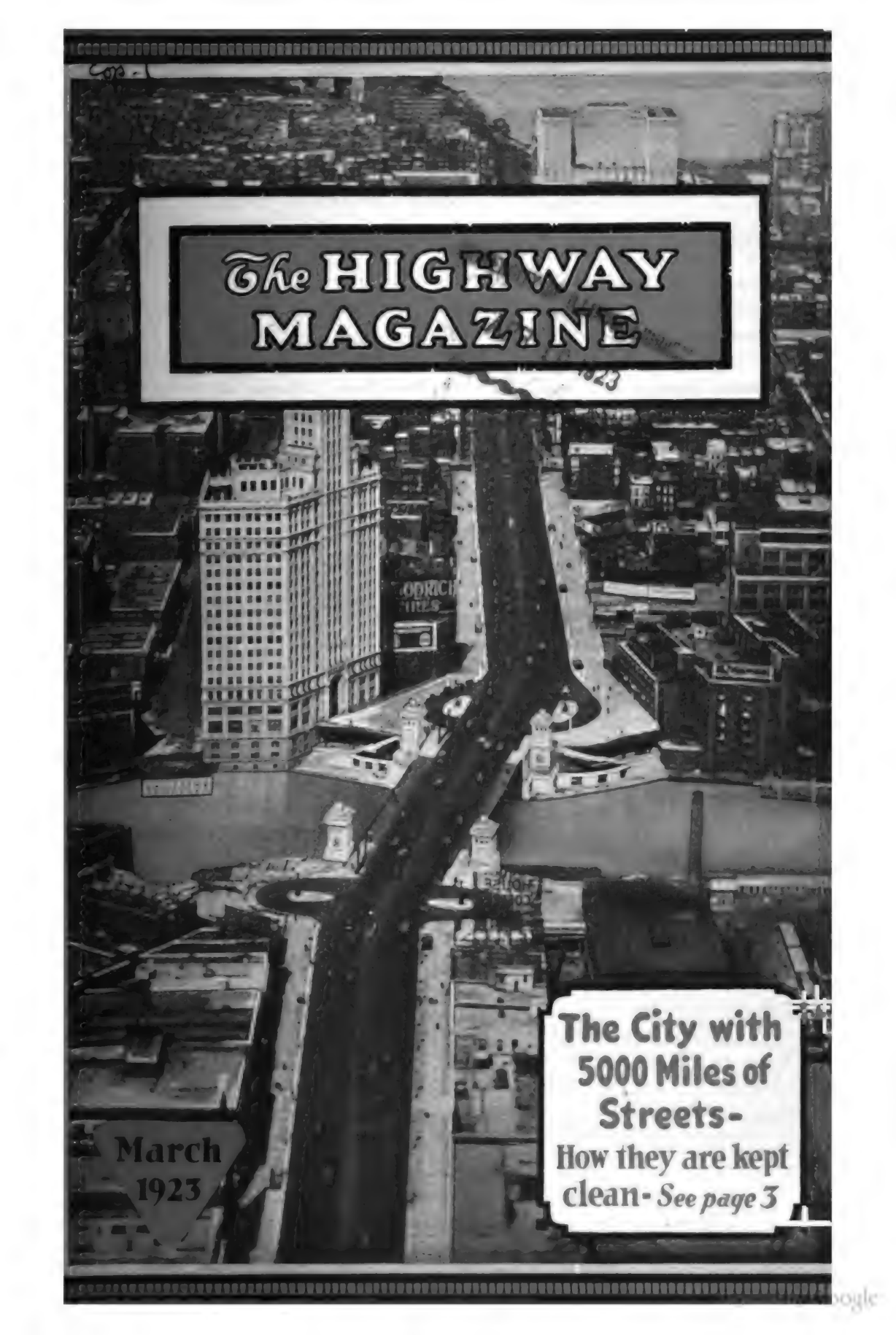
Elastic Below

An elastic culvert construction is desirable in all cases, to withstand the great pressures that may be developed by shifting or hardening soils, or by the impact of traffic.

ARMCO CULVERTS

—because of the arch-like corrugated structure of the sheet metal, have the high elasticity necessary for reliable culvert service. With this they combine the indispensable quality of *purity* of metal, that makes them unique among all constructions in rust-resistance.

Fifteen years' service has proved that "Armco Culverts Endure."

An aerial photograph of Chicago, Illinois, showing a dense urban landscape. A prominent, dark, winding road or path cuts through the city, starting from the bottom left and curving towards the top right. The road is flanked by various buildings, including a large, ornate skyscraper on the left. The overall scene is in black and white, with a film strip border at the top and bottom.

The HIGHWAY MAGAZINE

March
1923

**The City with
5000 Miles of
Streets-**

**How they are kept
clean- See page 3**

**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
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Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Calgary, Vancouver, Vernon

The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIV

MARCH, 1923

No. 2

The Road Past Your Door ?



LOOK AT THESE PHOTOGRAPHS AND THEN READ THE
ANNOUNCEMENT ON PAGE 6

This is the road past someone's door. If you live in Santa Barbara, California, perhaps it is your door. The picture above shows Chino Street, Santa Barbara, in October, 1921. The photograph below shows the same street in June, 1922.



MARCH, 1923

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Office of Publication

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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

New Highway Building Records Made in 1922

ALL records for road construction in the United States were surpassed during the fiscal year of 1922, according to the annual report of the Bureau of Public Roads. During that period 10,000 miles of Federal-aid roads and more than an equal mileage of highways without Federal assistance were constructed. The roads brought to completion during the year averaged over 200 miles for each state. The greatest increase is reported from Texas, which added during the year 933 miles to its completed highways. Five states show an increase of more than

500 miles each and of this number three are Southern states, namely—Arkansas, Georgia, and North Carolina, the other two states being Iowa and Minnesota. A number of states, such as Louisiana, Maryland, Massachusetts, and Rhode Island made notable advances toward the goal of a completed highway system. The largest payment of Federal-aid during the year also went to Texas, which received from the Government \$5,915,046 and earned nearly \$2,500,000 more.

The total length of projects throughout the country in all states, including those which have been completed and those which are in the stages preliminary to construction is 39,940 miles, 4,538 miles greater than at the close of the preceding fiscal year, when projects completed aggregated 7,469 miles and there were 17,978 miles under construction, estimated as averaging 50 per cent complete. In one year the completed mileage has shown an increase of more than 10,000 miles and there remains under construction 14,513 miles estimated as 56 per cent complete.

A total of \$166,911,500 has been paid to the various states on completed and uncompleted projects. When the past fiscal year opened there was an unobligated balance of about \$18,800,000 of appropriations, and by the end of October, 1921, the balance had been reduced to \$11,700,000, the lowest since 1918. Following the approval of the new Federal Highway Act the initiation of projects took on new life and in the months of March and June reached the unprecedented total of 1,250 miles a month.



This army of "White Wings" is employed to keep the streets clean in a single Chicago ward. Chicago wards have an average population of 80,000.

How Chicago's Streets Are Cleaned

By THOMAS A. BYRNE

Superintendent of Streets for the City of Chicago

Chicago is not only the "Windy City" but the "Dusty City" as well, and the problem of keeping its 5,000 miles of streets and alleys clean is a stupendous task. The following article, prepared especially for Highway Magazine, tells how this is accomplished.



Chicago in 1831—92 years ago—showing Ft. Dearborn and the Chicago River at the point pictured on the cover of this magazine. Street cleaning was no problem in those days.

THE cleaning of streets and alleys, and collection and removal of wastes (garbage, ashes, and miscellaneous refuse) is vitally associated with the health, comfort, and convenience of a community. The frequency and thoroughness with which this kind of service is rendered is naturally dependent upon the funds provided for that purpose, and Chicago's growth has been so rapid, that it today finds itself confronted with a number of important problems to bring its street-cleaning system to the point of greatest efficiency.

The streets in Chicago are cleaned on an average of every other day. This is the minimum any street should be cleaned. Streets should be cleaned daily, and our downtown streets are cleaned daily. Chicago is an exceptionally hard city to keep clean. It is filled-in, built on swamps. It has a poor sewage system. It is very dusty and smoky. Chicago lies at the door of the Indiana and Illinois soft coal mines, and this soft coal is its principle fuel. Chicago is the greatest railroad center in the world; it has thirty-two trunk lines daily entering the city and, unlike New York, its terminals are not electrically operated. Belching locomotives spread smoke and cinders all over the downtown district. Chicago is

a city of flats, with flat roofs. In the downtown section alone, the flat-roof area is six times that of the streets. An ordinance was passed several years ago, requiring the tops of buildings to be cleaned at least once a year, but the ordinance is not generally enforced. Thus we find our roofs great dust producers. No matter how often we flush our streets, (and we do flush them every night, excepting in freezing weather) in the morning, as soon as traffic begins, a fine dust lifts on the pavement. That is why it is necessary to contract for sprinklers in Chicago.

We now have eighteen large power flushers. These work in two shifts of 16 hours a day. They do about 12 miles to a shift. Thus, we are able to flush every other day 400 miles of car-line streets. Our plan is to add ten flushers a year to our equipment, until we have fifty. That will enable us to flush all the streets in Chicago once a day.

To systematize the street-cleaning work, the city has been divided into wards, each in charge of a superintendent, who in turn is responsible to the Superintendent of Streets for the physical condition of his ward. The ward is subdivided into sections, each section being in charge of a section foreman, who in



A typical modern office from which street cleaning is administered in each Chicago ward.

turn reports to the ward superintendent. In this way, the Superintendent of Streets in charge at the City Hall is kept in constant touch with every phase of the street-cleaning activities and the operation of every section. When you take into consideration that each ward in Chicago is a city in itself, the average population of a ward being upwards of 80,000, which is a greater population than any other city in the State of Illinois, you will realize the responsibility of a ward superintendent.

In 1916, after carefully surveying the needs of the city, we were successful for the first time in securing sufficient funds to carry out a program which provided for regular and efficient service. Today, we are laboring under an appropriation \$1,500,000 short of the amount which should be set aside to maintain the standard established in 1916. There has been considerable increase in the mileage of paved streets, labor and material have also increased in cost, and 50,000 new homes have been built.

Chicago is often compared unfavorably with eastern cities as to its cleanliness, but here are a few illuminating figures. New York receives 466 per cent more than Chicago for street and alley cleaning; Boston 254 per cent more; Philadelphia 107 per cent more. Of all the large cities in the country, Chicago is working with the smallest appropriations, and covers by far the largest territory.

Chicago is 15 miles wide, 26 miles long, and contains 200 square miles. It has 2,188 miles of paved streets and 1,089 miles of unpaved streets, totaling 3,277 miles of streets. It has 337 miles of paved alleys, and 1,400 miles of unpaved alleys,

totaling 1,737 miles of alleys. In this connection, it is interesting to note that the majority of our cities throughout the country do not provide their citizens with the convenience of alleys, which add just that much more mileage to be kept clean and in good repair. (New York has but 1,500 miles of streets, and no alleys.)

In 1913, our street cleaning force numbered 1,800 men. Today it has only 1,200 men, although we have about 600 miles more of paved streets than in 1913, and the city's population has been growing at the rate of 10 per cent a year. Automatic sweeping machines, each of which replaces 20 men, are being installed as rapidly as our funds will permit. Eleven of these machines are now in operation. Also, the physical condition of our street mileage has been vastly improved since 1913, permitting of greater efficiency with less labor.

We are looking more and more to machine sweeping, because the City of Chicago is a large employer of common labor, and like all other employers of common labor, we are affected by immigration. There was a time when the Irishman swept the city streets, but he does not do this class of work any more. The Italian now sweeps the city streets, but his son will not want to do so. So the day is not distant when we shall have to depend entirely upon automatic sweeping machines to keep our city streets clean. Street-sweeping, while it is now paid as well as any other common labor, is looked upon as a lowly occupation, and we who are in charge of that work see the handwriting on the wall. We are preparing for the time when this work must be done entirely by machines. There are one or two manufacturers who are now developing, and, in fact, have perfected a highly efficient street-cleaning machine. We are adding to this equipment every year.

In the downtown section of Chicago, the principal work of street-cleaning is done at night, but the streets are patrolled all day. In fact, in this section, men are never off the streets; shifts are constantly at work. Storage boxes for street sweepings are placed in every block; in the downtown district there are four of these boxes, of large size, to the

block. The accumulations of an eight-hour day are removed from these receptacles each night, into trucks, and carted to a loading station at the foot of South Water street. The outlying districts have smaller boxes, which are emptied regularly. There are about 12,000 of these boxes now in use, and the service is being enlarged at the rate of about 1,000 boxes a year.

The time is not far distant when Chicago will be without adequate dumping facilities. All the old clay holes and low-lying lands which are within reasonable distance, have been practically filled. The filling in of our Lake Front and its future improvements will furnish an outlet for a great deal of waste material, but hauling through a congested district like our "loop" is both unsatisfactory and costly. The evident solution of this problem is to provide funds for the purchase of convenient places for disposal of wastes.

Chicago's street-cleaning force presents a better appearance than that of any other American city, not excepting New York. That statement I make because I recently made a tour of all the large eastern cities, and I paid particular attention to the street-cleaning personnel. In the downtown section of Chicago, which is our front yard, our men are required to change their uniforms three times a week. They are encouraged to shave every other day, and to shine their shoes occasionally. In fact, we try to impress upon them the importance of keeping themselves clean,



Here a supervising street cleaner is, in turn, training section foremen.

and they are beginning to do so without our telling them.

Keeping our streets clean involves the purchase of about 1,500 dozen brooms each year, and about 1,000 dozen shovels, which are bought from the House of Correction, as are also the receptacles into which the street sweepings are emptied. This institution also furnishes much of the stone for repairing streets. In addition, about 10,000 boulevard scrapers are used.

When Chicago completes the paving of her alleys, the number of teams for collection of waste can be considerably reduced, as each team will be able to cover proportionately more ground in a working day. Also, there will be much less dirt and rubbish carried into the paved street by traffic from the unpaved alley. We are now installing a splendid type of tractor and trailers in the ash collection service.

I cannot impress too forcibly the great need for constant co-operation from the public at large in keeping the streets clean, and the great assistance which can come from local organizations and civic clubs in educating the residents of their neighborhoods to comply with the ordinances in the matter of providing proper and sufficient receptacles for waste and the placing of these receptacles adjacent to the alleys on collection days. It is often stated that a city is as clean as its people, and it is co-operation that makes for a healthier, cleaner and more beautiful city.



A section foreman showing the street cleaners how to handle the broom.



Write the Story of "The Road Past Your Door"

A PRIZE essay contest for high school students on the general subject of "The Road Past Your Door" was announced in the February issue of *The Highway Magazine*. Cash prizes of \$25, \$15 and \$10 will be given for the three best stories submitted. Each manuscript sent in should give the name of the high school which the contestant attends and also the name of the principal of the school. The contest will close March 15th, and the winners will be notified by telegram before midnight of March 31st.

In full realization of the value of highway education among school boys and girls as a factor in the social, commercial, educational and religious development of the country, the publishers of *The Highway Magazine* are conducting this contest to stimulate interest in the good roads movement among young men and women of high school age.

The judges in the contest, who will be announced later, will include several representative men in the commercial and literary fields, as well as the editors of *The Highway Magazine*.

During the last several years, various organizations of a commercial and educational nature have

carried on successful prize essay contests for primary and high school students. The Highway Education Board and the National Automobile Chamber of Commerce recently conducted an essay contest on the subject of "How I Can Make the Highways More Safe," in which 400,000 primary school children competed. Stanley Newcomb, of San Diego, California, won the highest award—a gold watch and a trip to Washington—for his essay.

Mrs. Anne Rogers, a school teacher of Sterling, Colorado, won a trip to Washington, \$400, and an introduction to President Harding, who presented her with a diploma as writer of the best "safety lesson" in 1921. At the same time, J. S. Loomis, of Limerick, New York, was awarded a diploma for winning the National Grange contest.

Perhaps you have sons and daughters of high school age who would enjoy writing the story of "The Road Past Your Door." Every road has its story. Yours may represent an unusual piece of construction, or a failure to serve your community. If photographs will help to illustrate, send them in.

The winning stories, with short biographical sketches and photographs of the winners, will appear in the June issue of *The Highway Magazine*.



Master Stanley Newcomb



Mrs. Anne Rogers

Testing Materials for Road Construction

By W. A. NORRIS

Testing Engineer, Wyoming State Highway Department

A brief history of the movement to test highway materials, and the results of their selection on the basis of tests by the Wyoming State Highway Department, is herewith presented.

JUST as the coming of the good-roads era caused a revision of the old methods of construction, due to increased and variable kinds of traffic, so have those who realized the fact that any road is no better than the quality of materials that compose it, had to revise and devise standards and specifications for road materials that would meet requirements with new types of construction and the traffic that this construction must stand.

No longer is it accepted that a sand or gravel, or reinforcing iron or steel, or cement or brick or asphalt is suitable for use, simply because it has the appearance of being good. The wear and strain that such materials must stand in roads has been worked out on a technical basis for the various types and kinds of road. Therefore, it must follow that to obtain construction of certain qualities it is necessary to build these roads from materials that have a known value. This value can be ascertained only by thorough testing and constant regulation from a technical standpoint.

Several factors enter into the inspection, testing and regulation, for, as is well known, all the sand in a given sand pit or bank or bar very likely is not uniform throughout. It therefore, cannot be said that this sand is good or bad until it is tested against a standard to ascertain its quality, and even then constant retests and recommendations must be made to provide for quality variations.

In cement making every care is exercised during the process of manufacture in the way of chemical analysis of the ingredients, proportioning of the same, heat regulation and grinding, yet there are many cars of poor cement put on the market. Then, too, this cement, although good when shipped from the factory, may become damp—and slacked out—yet in appearance it is suitable. The same can be said of reinforcing iron and steel, culverts, asphalt, brick and all ma-



C. E. Proudley, of the Bureau of Public Roads, testing the impact resistance of road rock.

terials of construction. Consequently, among other requirements made necessary by the Bureau of Public Roads under the Federal Aid Road Act, there are series of certain definite standards and specifications that all materials, either of a natural local origin or of a commercial origin, must meet before they shall be considered as suitable for entrance into Federal Aid Roads. Since these standards are and have been determined by long and vigilant work on the part of material engineers and now have become a part of the preliminary work of a piece of road construction, no estimate can be made of the cost until it is definitely known that certain materials from a certain locality are acceptable for use.

Just as the chemical and physical laboratory under the supervision of able men has produced the telephone, radio, explosives, precious metals, etc., so has it developed and regulated the quality of

cement, asphalt, steel and iron and quality limits on sand and gravel, as well as the numerous other materials and their components in building construction.

Knowing these quality requirements is one thing, but getting them consistently is another, and no means of regulating this quality and being certain of getting it has ever been found, except by continual vigilance in testing. The variations in materials even within allowable limits, as well as the need for designing combinations that will permit of the use of inferior materials because of the prohibitive cost of good materials due to long haul or inaccessibility, has, therefore, necessitated a materials laboratory where the use and proper combinations may be tested to determine their value.

TESTING ORGANIZATIONS

Like all developments of any consequence, organization was necessary before anything definite could be presented as a guide for determining the quality of materials. To this end, the American Society for Testing Materials was organized some 25 years ago. The purpose of this Society is the promotion of knowledge of the materials of engineering, and the standardization of specifications and methods of testing. Since the A. S. T. M. provides for all materials in all kinds of construction engineering and manufacturing it developed that the more detailed investigations and recommendations must come from the individuals and organizations of the various professions. Consequently the American Association of State Highway Officials designated its Materials Engineer staffs to function along these lines. Likewise, the Bureau of Public Roads co-operates with the U. S. Bureau of Standards as well as maintaining a Testing Laboratory and Testing Staff of its own. These latter have developed sub-organizations with which they correlate all test data and thereby regulate and specify certain methods for sampling and testing highway materials in various localities.

As a result of this year's activities of the Sectional Committees and the later action of the Executive Committee, the American Association of State Highway Officials, co-operating with the Bureau of Public Roads, propose to issue a vol-

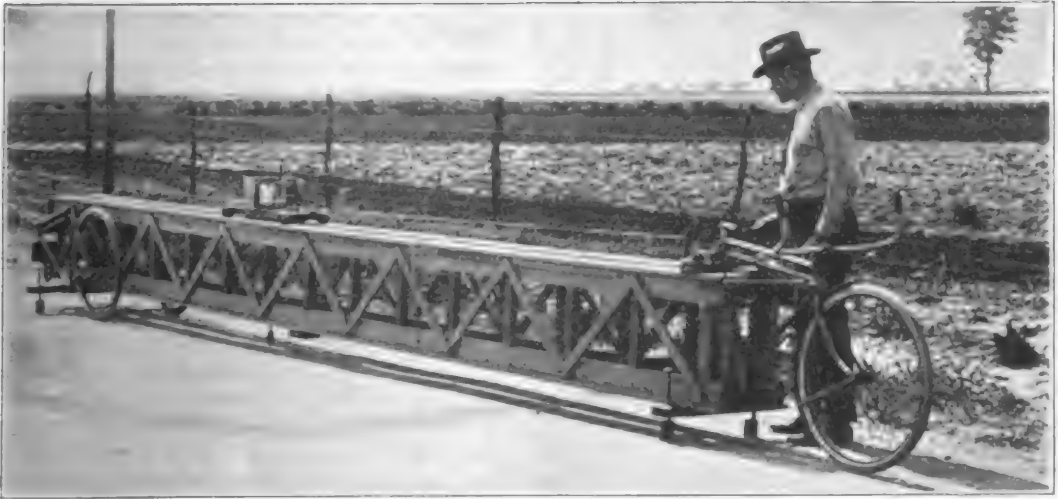
ume of Standard Methods for Sampling and Testing Highway Materials that shall govern practice throughout the United States.

Assuming that, to secure a piece of construction of good quality necessitates the use of good materials, it then becomes necessary, to be certain one is getting good materials, and that they are being properly manipulated during the actual construction to insure getting the best results. This, as said previously, can only be accomplished by constant testing. The fact that firms manufacturing products exercise care to insure uniformity, does not prove that their products are always the same, for, source of supply of raw materials vary as do the raw materials themselves. Then, too, the "human element" enters into the manufacture of such commodities even within the limits of any one concern, and since these products usually come from many concerns the variation is more apparent.

In the case of local materials, such as sand, gravel, rock, shale, water and even sub-grade characteristics there are within one state many types and kinds. Even in one segregated deposit of apparently similar sand, gravel or rock there are quite often wide differences in quality. It is, therefore, impossible to guarantee the suitability of any material without regular and systematic inspection and testing.

THE QUESTION OF COST

The fact that local deposits of material do vary in quality does not necessarily condemn all or certain parts of such deposits, for by systematic and definite investigation and experimental testing satisfactory combinations out of the ordinary practice may be developed whereby, for instance, a poorer quality of concrete sand may be used by porportioning the mix of sand, cement and water to secure strengths that will meet the specifications. In the case of gravel or crushed rock or selected material surfacing, the individual characteristics of each of the materials making up the surface combination as well as the characteristics of the sub-grade must be considered to get a surface that will hold its shape—give wear—and otherwise be mute evidence of its value as reflected by its cost.



This machine was devised by the Bureau of Public Roads to test the smoothness of highways. It records each irregularity and is one of the final tests of a road composed of tested materials.

Since cost is one of the primary, if not the chief factor in determining the necessity for a road, it follows that the cost of suitable materials is likely to be the most difficult item in an estimate to ascertain. Especially is this true when local materials are considered with commercial materials; for instance, the concrete aggregates in a stream over which a bridge is proposed may or may not be suitable for concrete—it is certain they will not be suitable as “pit run.” The only sure way of determining is to run a series of tests in comparison to standards to determine the texture (indicating voids), cleanness, soundness and strength. If the results are within allowable limits, very well, if not, the problem resolves itself into, either importing aggregates from some other locality, very likely from a commercial pit at a fancy price, plus freight, or depending on the Department Materials Engineer to design a box of extraordinary proportions, using the available local materials that will bring the finished concrete up to specifications.

No figures can be given to cover all cases of this nature, but there have been several instances where as much as \$5,000 to \$8,000 have been saved in cost due to designing and manipulating mixes of aggregate that would meet the

specifications, when if such had not been done the cost of construction would have been more costly or would have resulted in poor construction. Since contractors' bids are and must be dependent on the cost of suitable materials at the job, it is evident that “prospect work”—investigations—previous to the time the contract is to be let, are advisable. These investigations should furnish information as to the location, cost, accessibility and constructive features of the cheapest materials. With such information available for contractors at the time they are bidding, there is certain to result substantial reductions in their bids, or at least the department will have the advantage of knowing the reasonableness of their bids.

In summing up the work accomplished by this Materials Laboratory, it must be borne in mind that while we have accomplished much along the lines of material investigation and testing, we have been and are limited from a financial standpoint. It is difficult to educate the public and many of those in closer contact with highway construction in the need for materials supervision. The result is an endeavor to supply the demand of the government for test results on materials and deliver to the public first-class construction with suitable materials with the limited financial means



These materials are tested by the state of Colorado:

- (1) surfacing material;
- (2) cement, sand and gravel;
- (3) corrugated iron culverts;
- (4) water for concrete.

provided. Such a condition limits the amount and class of testing equipment as well as the number of those to do the work. Withal, however, the figures below are evidence of the work accomplished by the Testing Division of this Department, to date.

During the 1920-1922 biennium the amount of testing has increased 78.6 per cent over that done during the 1918-1920 biennium. From the figures in the table below it will be noted that of all the samples tested, 11.8 per cent were rejected as being unfit for use. Quite natu-

rally the greater part of these rejections were on concrete, sand and gravel, although the twenty-seven cement rejections represent eight casts as unfit for use. The large majority of the samples were taken by field engineers at the time the surveys were being made or as material checks during construction.

In addition to testing the materials and furnishing recommendations for their use, the Testing Staff supplies copies of all tests to District Engineers, Resident Engineers and Inspectors of the respective projects. Likewise, duplicate copies of each test are required to be submitted to the Bureau of Public Roads. A material plat book and file are kept showing the location and characteristics of material represented by each sample. This information is valuable for future reference in the case of making estimates for proposed construction.

The expense of operating a Materials Testing Laboratory is pro-rated on the same basis as engineering. That is, about 65 per cent of the material testing expense is assumed by the Federal Government under the provisions of the Federal Aid Road Act. The following figures showing cost of testing include all items of expense incidental to testing during this biennium with the exception of laboratory equipment purchased, this latter amounting to \$277.15.

Total Salaries	Total Expense	Gross Cost
\$6,180.70	\$856.71	\$7,037.41
Net Cost to Department	Assumed by Federal Aid	Total Cost of Construction
\$2,463.10	\$4,574.31	\$3,847,573.60

From the above figures it is apparent that gross cost of material testing represents eighteen hundredths of one per cent (.182%) of the gross cost of all construction.

Class of Material	Number of Samples Tested			
	Last Biennium	This Biennium	Total to Date	Representing Rejected Material
Portland Cement	157	187	344	27
Corrugated Culverts	78	44	122	0
Concrete Sand	172	433	605	96
Concrete Gravel	172	420	592	35
Surfacing Material	125	245	370	5
Oil and Asphalt	15	22	37	4
Shale	64	68	132	18
Water—for concrete	10	21	31	5
Reinforcing Steel	51	72	123	0
Rock	19	30	49	13
Totals	863	1542	2405	*203

*Note.—This figure represents the rejected samples during this biennium only. The ratio of rejected samples to the total number of samples tested during this biennium is 11.8 per cent.

The Road Over Red River Pass

By E. W. LOVERIDGE

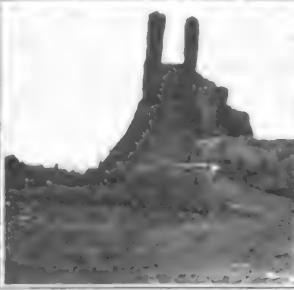
Supervisor, Carson National Forest, U. S. Forest Service

A visit to the Taos Valley, the burial place of the famous Kit Carson, and today as primitive as when entered by Coronado's men in the year 1542.

At right is shown a birdseye view of Pioneer Canyon, looking toward Red River; below, at left, is seen the little city of Red River, nestling in the valley.



The ruins of the old church at Taos Pueblo, destroyed during the Indian Rebellion of 1847, are shown below at center. The other view is of Wheeler's Peak, from the North.



THE popular idea that an auto journey through New Mexico means nothing but a dusty jaunt over unpopulated sage-brush flats and cactus-covered deserts will leave the traveler forever, if on the trip from West to East he follows the northern division of the Sante Fe trail to Taos, and from there takes the magnificent road over Red River Pass.

Any one of the many wayside attractions of the region would be advertised to the world, if aggressiveness were not unknown to the native Mexicans and Indians, and altogether contrary to their philosophy of "puede que manana" (Maybe tomorrow).

There has been for several years a colony of artists in the village of Taos, but artistic temperament is not inclined to advertise the attractions to others. Their reproductions on canvas of the scenic features of this region have, nevertheless, found so wide a vogue in art circles that the beauties can be said to

have achieved some noteworthy recognition even though they are still missed by the many travelers who use the main highway just a few miles to the east.

The Taos Valley, which is crossed on the western approach to the Pass, is completely surrounded by mountains. To the east and north bold heights arise with successions of rugged contours, while off toward the setting sun lie low distant ranges. Adobe settlements dot the fertile fields to the very rim of the deep cut canyon of the Rio Grande.

The one-house Indian villages, with their quaint four or five storied structures of mud and straw supported by floor beams from the nearby forests, are of unusual interest to the tourist. The Taos Pueblos remain the most remarkable of the communal dwellings of the Southwest.

Nearby, in the summer, the Indians hold their corn dances, ride gaily to the rabbit hunt with their primitive bows and arrows and continue their customs



One of the adobe dwellings—the Taos Pueblos—for which Taos Valley is famous.

of life as found at the time of the visitation of Coronado's men in 1542.

There are ancient ruins of other pueblos and early Spanish missions; the old adobe house occupied by Kit Carson and the grave of the brave frontiersman; hot sulphur springs and groves of giant cottonwoods. It is a dreamland where the present fades away into an infinite past.

Along the base of pine-clad mountains winds the roadway north from Taos through Questa, a Mexican hamlet, into the canyon of the Red River. From the Red River come the waters that make the Sunshine Valley, spreading out below, a gorgeous garden.

In early times, little heed was given to ideas of conservation and here as elsewhere in the Southwest, devastating forest fires swept the hillsides and destroyed their moisture retarding cover. Heavy rains and fast melting snows came roaring down in torrents to be followed by a scantiness that threatened farming ventures. For fifteen years now, however, the U. S. Forest Service has guarded this watershed and it is gradually returning to a condition of regulated stream-flow that the relatively dense population, entirely dependent on the waters that come from the mountains, is learning to appreciate.

Through the canyon the stream makes noisy music while there comes to meet the traveler the romance of old mining towns. To Anchor, Midnight and Red River rushed the gold hunters in the sixties. They found some ore, and thousands of pounds of heavy mine and mill machinery were freighted in from the end of the railroad at Dodge City, Kan-

sas, 500 miles away. Much of this still lies scattered about where it was left by disappointed fortune seekers.

To this day the old timers thrill the younger generations with the tales of the way Long John Dunn handled his "fours and eights" in bringing the stage and mail over the old pass.

The old route twisted through a gap in one of the most remarkable series of heights in the Sangre de Cristo Range which culminates in the towering crest known as Wheeler Peak. It is the greatest altitude reached in New Mexico, almost fourteen thousand feet above the sea. From its bald summit spreads a vast panorama of purple-hung mountains, deep sheltered lakes, flower-filled meadows, primeval forests, giant spruce and slender aspen, precipitous canyons, tumbling streams and leaping cascades—a true camper's paradise with all the lure of the primitive and unusual.

The mountains, the flowers, the lakes, the spruce and the aspen are still there as in the time of Long John and his breath-taking stage trips, but now the ride over the Pass can be made with ease and comfort on a road that is conceded to be one of the best example of mountain highway construction in the West.

It was built by the Forest Service in 1916, and the maintenance has been a matter of such pride with the local ranger under whose supervision it is, that damage by cloud-burst and flood is repaired almost before the wind has blown the mists away. The road patrolman, too, is so anxious to keep his highway free from stones that he clears it with a hand rake!

Irrigation and Drainage



Irrigation Development Under Montana's Public Service Commission

*Red Lodge-Rosebud project brings 9,756 acres under water at
an estimated increase in land values of \$575,500.*

THE first irrigation project to be developed under the jurisdiction of the Montana Public Service Commission as provided by the new law passed in 1921, is that of the Red Lodge-Rosebud Irrigation District (irrigation project No. 10), located in Carbon County, Montana.

The first bond issue under the new law (Chapter 153, Sec. 3965, Code 1921), for this project totalled \$418,000 which will be used in construction work, acquiring property and water rights and the purchase of previously constructed irrigation canals, etc.

The total area of the Red Lodge-Rosebud District is 21,555 acres of which 9,756 acres will be irrigated. About 85 per cent of the irrigable acreage is now under cultivation and the entire acreage is exceptionally free from timber, stumps

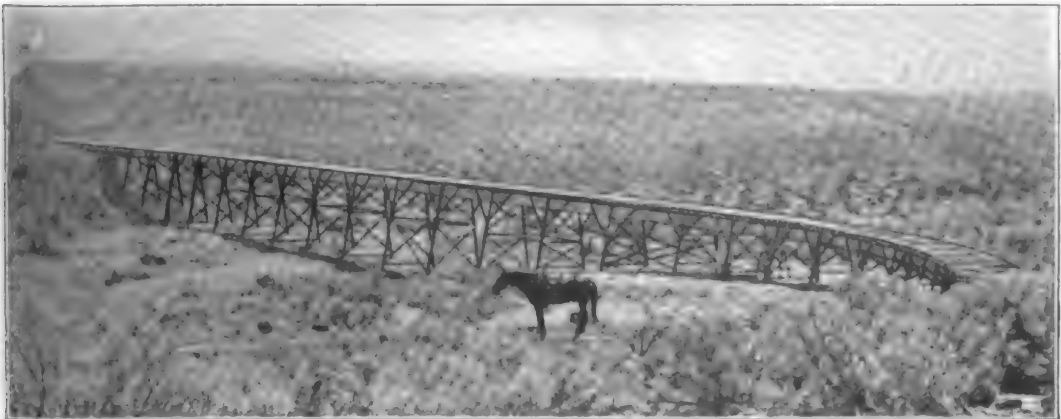
or brush, as part of the land has been farmed for the past 30 years with an average of 12 years for the entire district.

The average elevation of the district is 4,700 feet above sea level—rolling bench lands on the north slope of the Bear Tooth Mountains. The topography of the country is such that drainage works will not be necessary.

The soil is very fertile and retains moisture well. The principle crops are grain and alfalfa; stock raising and dairying will be the prime industries.

Water will be obtained from the East Rosebud River which gives a continuous and ample supply so that storage facilities and pumping equipment will not be necessary.

The estimated duty of water is one and one-half acre-feet net delivery, with



This Armco flume carries water to the thirsty desert land. It is 50 miles from a railroad and the lightness of the construction material saved its builders many dollars in hauling charges.

canal capacity capable of delivering half this amount in 30 days.

The first 10 miles of the main canal were built 20 years ago at a cost of \$100,000 which the district purchased recently with all water rights for \$27,000. The average conductance from the intake to the farm unit is 20 miles.

The completed system will include, besides the main canal, two large syphons, several flumes and other structures.

The total assessed land value of the district for 1921 was \$348,000 while it is estimated that the total value of the land of the district after irrigation will be \$923,500, an increase of \$575,500.

The annual operating cost of the completed project is estimated to be \$1.00 per acre per year.

The present population of the district is about 550 persons—106 are land owners in the irrigation district, every one of whom will benefit materially by the great increase in land values and the greater producing power of the land under irrigation.

The nearest towns and railroad shipping points are Fox, Roberts and Red Lodge, which are within 10 miles of 80 per cent of the acreage in the district.

Big Water Power Development Projected

AS showing the vast extent of hydro-electric developments in this country today, some impressive facts are to be found in the annual report of the Federal Power Commission, recently issued. During the last two years an aggregate of 321 applications were filed, amounting to more than 20,000,000 horse power, or over twice the horse power of the existing water power plants in the United States. During the second of these two years there have been projected developments for a total of 5,000,000 horse power.

Applications for the installation of plants on the St. Lawrence River, the Colorado River and the Columbia River account for nearly one-half of the 20,000,000 horse power aggregate.

Considering opposition that has developed in various quarters to the Federal Water Power Act the report says—after noting direct assault upon it—that “of equal importance and perhaps of greater danger are the indirect attacks upon the Act. * * * The results already accomplished afford convincing evidence that granting of special privileges is not necessary in order to secure the development of all the electrical energy the market can absorb.”



A pair of automatic drainage gates of the Calco type, which prevent back flow and consequent flooding of drained lands. Note the well designed concrete headwall. These gates are attached to Armco ingot iron corrugated culvert pipes.

Irrigation—Old and New

By C. L. CHATFIELD, *Irrigation Engineer*

The following discussion of some of the results of irrigation is digested from an article recently published in the official Bulletin of the Colorado Society of Engineers.

CULTIVATION of the earth, whether irrigated or non-irrigated, is directly or indirectly the basis of all wealth, but irrigation in the West tends to eliminate the speculative factor in farming operations. The basis of irrigation securities is sound.

The days of wildcatting in irrigation is past, the same as in mining operations, and development has been placed on a business basis.

The farm on a unit basis pays dividends or all farming would cease. Therefore there is absolutely no reason for the failure of a whole irrigation project if properly handled.

In Colorado, at present, about 3,350,000 acres of land are irrigated, producing crops valued normally per annum at roundly \$100,000,000. Is there any reason why the additional 2,000,000 acres cannot be also placed under ditch and increase this value to \$160,000,000 each year?

Assuming that it did cost \$100,000,000 to place this 2,000,000 acres under irrigation it would pay, and pay in staggering figures. Think of the increase in population, remembering that it requires much less irrigated land to support a given population than of dry farmed or grazing land.

The money situation is improving rapidly and eastern capital is seeking places for safe investment in the West. Let us come alive at once—not tomorrow—and offer these people opportunities which they will not have reason to regret.

The Cache la Poudre basin in the vicinity of Fort Collins and Greeley is the oldest irrigated section in Colorado. It is a pleasure to drive from Denver north to that area, traveling through well farmed country all the way. Beautiful farms stretch as far as the eye can see. In the South Platte basin from the foot-



Ancient irrigation—lifting water by means of a treadmill in old Japan.

hills to the state lines lies one-third of the irrigated land in the State of Colorado. It is termed intensely farmed land, and is in a general sense, but would you believe it if you were told that on every side the rankest extravagance and waste is going on under your very eyes? You would not, but it is a fact.

A veritable network of canals traverse the irrigated area. As a matter of fact there are over 1,300 main ditches, aggregating 4,860 miles in length with a carrying capacity of 36,800 second feet and 1,100 lateral ditches, aggregating 2,230 miles in length. The stupendous total of 7,090 miles of main ditches and laterals, practically all of which are unlined, are required to serve this land. An average of about 35 per cent of the water taken from the streams is lost by percola-

tion through canal banks and bottoms before it reaches the point of application. These losses are due to wasteful methods of application of irrigation water to the fields.

The gross diversion per annum is roundly 2,000,000 acre-feet, of which 700,000 acre-feet is lost by reason of unlined canals; 700,000 acre-feet is equivalent to a continuous flow throughout the active irrigation season of 210 days of 1,680 second feet. Good water rights in the South Platte basin are valued at from \$5,000 to \$13,000 per second foot, an average of \$9,000. This water that is lost represents a value of \$15,120,000 at present prices and would be worth far more by reason of the enhanced value due to more intensive development.

Again a great many of even our oldest systems where water rights are most valuable are greatly in need of reconstruction.

The systems of distribution under them are oftimes such that equitable division among farmers is impossible. A great deal of money could be spent in a judicious manner that would pay big returns to the farmers and stockholders. The field is unlimited and water rights are increasing in value from year to year. A farmer takes the best of care of every piece of property except of that which really gives value to said property—his water.

The motto seems to be "hold down the cost irrespective of the consequences." The principal reason for this is that the average farmer keeps no books.

It is up to the engineering fraternity to demonstrate to the farmer the absolute necessity of plugging the big hole through which his profits are being lost.



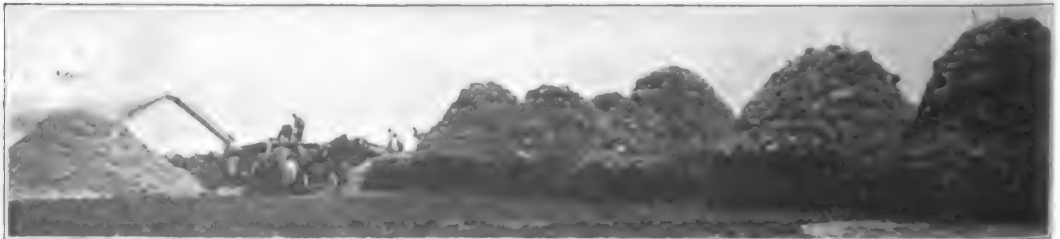
AN INTERESTING INSTALLATION

This photograph shows the interior construction of a flume made of rust-resisting Armco ingot iron. Thousands of feet of this type of metal flume are employed today on the great irrigation districts of the West, and the metal is in perfect condition after years of service.

—Dumbarton

\$80 Acre Cost on Horse Heaven Project

THE January issue of *Highway Magazine* contained an article on the great Horse Heaven Irrigation District in the State of Washington, in which the estimated cost per acre, as a result of the developments described, was incorrectly stated. The cost per acre will be \$80 instead of \$880, as noted in the aforementioned article.



Threshing a wheat crop from an irrigated area near Shelton, Nebraska.

Feeding the Brute to Discover Its Habits

ARMCO
INGOT IRON
Resists Rust

THIS picture shows the testing yards where we continually feed metal to the great iron-eater—rust.

Snow and rain, cold and heat—all the elements are given a chance to show their power of destruction on sheets of ARMCO Ingot Iron and other metals.

When the metal sheets have been there for months, the chemists and metallurgists examine sections under a powerful microscope. To an outsider, the difference in effect on ARMCO Ingot Iron and other irons would be a revelation.

The survival of ARMCO Ingot Iron is due to its purity. Foreign matter that invites rust has been eliminated during the special process of manufacture.

These testing yards and our extensive research laboratories are indications of the great, unceasing care taken to maintain the purity of ARMCO Ingot Iron. If you are a user of iron products where rust-resistance is required, write to us.



Snow-covered Testing Yards at ARMCO Plant



This triangular trademark on culverts, flumes, siphons, tanks, road signs, roofing, etc., is your assurance of quality and unequalled rust-resistance.

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MIDDLETOWN, OHIO

No guesswork
about durability



*Photo of date tag
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This date tag

--an added mark of confidence
in lasting service--is now used
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check definitely the durability
of rust-resisting Armco Ingot
Iron, of which these culverts
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culverts are tagged with the
Armco name and date, and
avoid substitution of inferior
metals.



In service since 1909 under the Dixie Highway



In perfect condition after twelve years' service



25.705
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The HIGHWAY MAGAZINE

April
1923

**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
Ingot) Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Calgary, Vancouver, Vernon

The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIV

APRIL, 1923

No. 3



More Haste— Less Speed

In our hurry to get from place to place as fast as possible, we often forget the old adage, "the more haste the less speed." The driver of the automobile shown at the left was probably in a hurry. Call the junk wagon! On the other hand take the case of Daniel Roche, formerly of North Wilkesboro, N. C. He didn't like farming conditions in his former community; so he hitched up his oxen and started for New Hampshire. The camera caught him in New York City, 68 days "out". He expected to reach his destination in thirty days.





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LOUIS A. GRAHAM, M.E.....Consulting Editor

Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Competition Keen in Good Roads Essay Contest

Prize winning stories to be published in an early issue of Highway Magazine.

AS this issue of *Highway Magazine* goes to the press, the Prize Essay Contest for High School students on the subject of "The Road Past Your Door" is in full swing.

The Contest opened with the February issue of the magazine and closed at midnight March 15th. The winners of the first, second and third prizes were scheduled to receive notification from the judges before midnight of March 31st.

So many excellent essays were sent in that it has been decided to award honorable mentions to many of those that did not win a cash prize, but whose essays showed a good knowledge and deep appreciation of the road building problems of the nation, as typified by the local road described. The winning essays, together with the names of those who received honorable mention will be published in an early issue of *The Highway Magazine*.

The Contest demonstrated that thousands of High School students possessed, not only a keen interest in the better road movement, but a comprehensive knowledge of the problems of road building. It showed that the good roads education of young men and women of High School age is not being neglected, and

that the highway problems of the future will be faced by those who possess a fundamental knowledge of the value of good roads.

Many High School principals and instructors in English, Civics and History took an interest in the Contest and helped their students in the competition. The editors wish to thank these High School principals and instructors for their co-operation.

Scores of newspapers, as well as many civic organizations and good roads bodies gave publicity to the idea.

The widespread interest evidenced was an indication of the attitude of the "younger generation" toward the good roads movement. This interest in road problems among High School students should be stimulated. The student of today is the worker of tomorrow. In his hands will rest the future of the nation—its social and commercial progress. Good roads are a vital factor in national development, as good roads are necessary for the maintenance of national progress.

Grade Crossings in United States

ACCORDING to records of U. S. Bureau of Standards there are 251,939 railroad crossings in the United States. In 1921 only 399 railroad crossings were eliminated, the average cost being \$50,000.

President Harding Urges U. S. Join Road Congress

IN a recent message from President Harding to Congress there was included recommendation that the United States become officially represented in the Permanent Association of International Road Congresses. A part of the President's recommendation was that the Secretary of Agriculture be permitted to advance the necessary funds for membership out of an administrative fund provided by the Federal Highway Act of 1921.

"I believe it is altogether desirable," said the President, "for the United States to have representation in this association, and I strongly recommend the granting by Congress of the authority requested by the Secretary of Agriculture."

Something New--The Patented Highway!

By GEORGE L. BYROM,

Paving Engineer, City of Houston, Texas

How a Texas engineer has invented a unique hard-surfaced highway that costs slightly more than a gravel road.

IN South Texas and in alluvial Louisiana, where all road materials have to be shipped in, the problem of the permanent highway has been solved in a way that is not only practical and economical but entirely new and unique.

S. B. Moore, formerly the Southern Pacific's Construction Engineer of the Atlantic Lines, has patented a hard surfaced highway that can be constructed for but slightly more than the cost of a gravel road and at the same time possesses the structural advantages of a highway that would cost close to \$75,000 per mile to build. Such a road, built of solid concrete with a bituminous surface, while highly desirable, is a commercial impossibility, yet Mr. Moore has designed and built several roads of his new type that to all intents and purposes give almost identical results.

In dry weather the soil of many unpaved roads is amply firm to support heavy traffic, but it is immediately softened and rendered impassable by wet weather. If the soil is topped with some kind of road metal, this acts as a roof over the embankment and also as a wearing surface; and as long as the topping



The concrete lanes, ready for surfacing.

remains intact traffic is carried reasonably well. Unfortunately all porous tops quickly become rough, and traffic will form a rut which catches and retains water, and when the water seeps through the top and centers the soil of the em-



Laying the concrete beams, or "traffic lanes" for the highway described in the accompanying article. A surface of bituminous macadam is placed over these lanes as is shown in the photograph on the next page.



The completed highway, showing the permanent ruts or wheelways.

bankment it is but a short time before the road becomes impassable unless costly repairs are made.

As drivers seem determined to follow a rut, and as a rut is the quite general cause of the failure of all types of highways, Mr. Moore determined to make it the reason for the success of at least one type of road and proceeded to place a concrete beam down into the road bed of sufficient width to accommodate the vary-

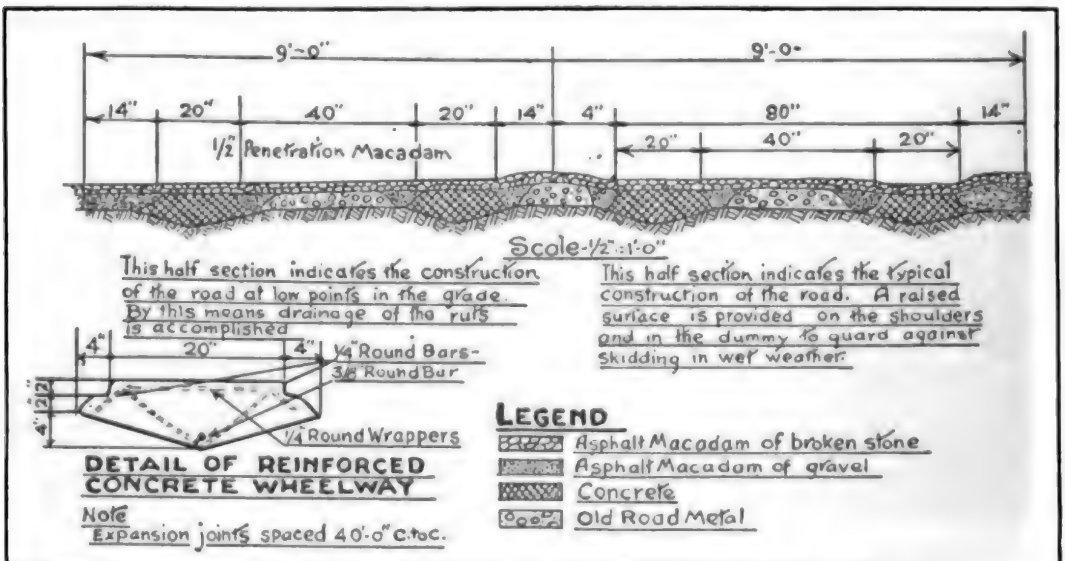
ing gauges of motor vehicles. Then over the entire road surface he placed a bituminous macadam topping, with ruts preformed directly over the concrete beams. By designing the beam on the T-Beam principle he was enabled to get enormous strength by the use of a surprisingly small amount of material.

In considering this road one must guard against forming the conclusion that it is a trackway. It is far from it. It is a waterproof surface constructed in such a manner that most of the traffic will occur in preformed ruts and the ruts are constructed to take the wear. The rest of the surface will receive much less wear, and will consequently have a long life.

Under present traffic regulations practically every highway structure in our country is frequently overloaded and is eventually destroyed by loads far in excess of its capacity.

Mr. Moore's road is capable of almost exact determination of the load under which it will fail. When selecting the type to be constructed the maximum load that it is to carry can be provided for and thereafter the loading restricted to the limits of the design.

Unless some action is taken to restrict a very few selfish truck drivers who insist on moving over our highways loads that destroy them, the country will soon be bankrupt.



Diagrams, showing the detail of the special reinforced highway

Corrugated Culvert Extension Eliminates Highway Death-Trap

By A. T. LOBDELL,

Division Engineer No. 8, Nebraska State Highway Department

How a traffic menace on a Nebraska State Highway was removed by the use of corrugated iron culvert pipe.

A DANGEROUS washout on Nebraska State Highway No. 35 at a road intersection seven miles north of Schuyler in Colfax County, was recently eliminated by the simple expedient of checking soil erosion.

This was accomplished by extending two culverts already installed to a point where they had their outlets in a single spillway, the removal of a third culvert which was rendered unnecessary by this installation, and restoring the shoulder of the highway.

Several elements combined to make this point particularly hazardous to the motorist who was not entirely familiar with the section. Trees obscured the vision at the point of intersection of the two roads. The outlet ends of three culverts, all installed at different angles, converged toward a common point, and in the course of time this consequent concentration of surface water had eroded the light soil, forming a hole 17 feet deep.

The wreck of an automobile can be seen at the bottom of this hole in the picture at the top of the page. After its plunge it was not worth salvaging.

A 26-foot length of Armco ingot iron corrugated pipe, 48 inches in diameter, together with a special elbow and connecting band was attached to the 48-inch culvert already in place.

Twenty-four feet of 24-inch pipe was attached in a similar manner to the 24-inch culvert already in place. A single concrete headwall and spillway for both culverts was installed, as shown in the center photo at the right.

The 17-foot hole was filled and the shoulder restored with a 1.3 slope. Part of the trees and shrubbery were cut away to give clearer vision. The result is a perfectly safe intersection and the elimination of an unsightly hole that would have continued to become increasingly dangerous if erosion had not been checked.



Washout caused by uncontrolled drain water. Note the wrecked car in the hole.



How the culverts were run to a special concrete headwall and spillway.



After the completed structure had been filled in.

A New Method of Highway Map Making

By E. C. GAMBLE

How an engineer has worked out a "picture to the mile" idea in highway guidance.

WHEN the huge national program for the development of the nation's highways became an actual accomplishment, and the annual amount of motor travel took a sharp upward slant, the need for a simple and adequate highway guide became apparent.

The fine joy of travelling across country by automobile is often lost, with a speedometer check the only key to the existing guides. It requires a good deal of a technologist to use most road guide books intelligently, yet even a technologist is apt to slip in speedometer checking, often with aggravating results.

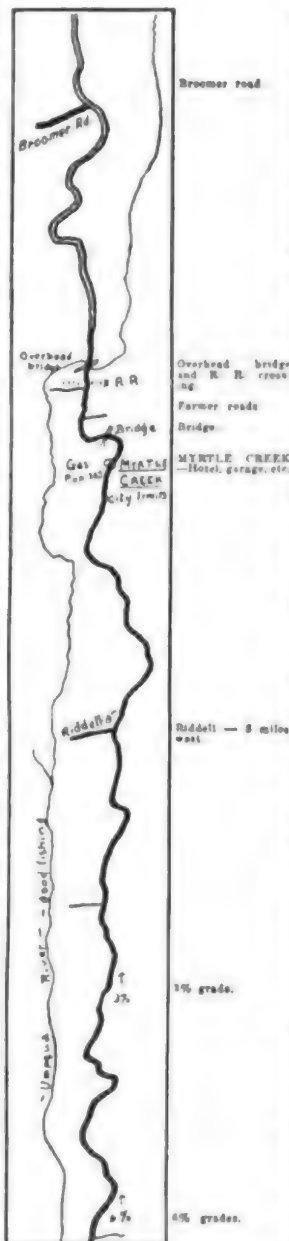
A guide book featuring a "picture to the mile" in conjunction with a special map (shown at the right) has eliminated guess work and the element of chance in highway guidance.

The pictures run in strips of ten to a page, a picture to the mile, corresponding to ten miles of road map, which shows plats and topographical maps of the entire highway on the horizontal scale of one inch to the mile.

The general contour of the country is featured so clearly in strip photographs that even the most inexperienced amateur will not have the slightest difficulty making extended tours. On the white strip between the photos and the road maps, printed information relative to curvature and alignment of roads, gradients, bridges, overhead railroad crossings, detours, dangerous passes and highway junctions, is noted.

The pictorial guide tells the tourist exactly where all garages and service stations are located, and furthermore indicates all branch highways, and farm roads, stating specifically where they lead.

After photographing and mapping the State of California, and also publishing an Oregon State book, work was started on a New York to Portland, Oregon, book. A sixty-four day tour was spent in photographing and mapping the entire highway all the way from Portland to New York.



One photograph to the mile of road accompanies this new type of road map, as described in the accompanying article.



These are the men of Labette County, Kansas, who built more than ten miles of road in 43 working days.

When a County Engineer Turns Contractor

By A. R. BUCKINGHAM

Special Correspondent for The Highway Magazine

Labette County residents lay gravel in record time and pay for it with their spare labor in place of cash assessments.

THE farmers of Labette County, Kansas, probably hold the record for speed in building a gravel road by virtue of having completed a 10.52 mile section of highway in 43 actual working day. The cost was 54½ cents per square yard.

With W. J. King, county engineer, acting as boss contractor and the highway commissioners acting as a board of directors, ten miles of gravel road were constructed with home labor at a time when other counties had ceased road building because of excessive cost.

"The work was carried on at the rate of a quarter of a mile per day, or one mile every four days, which is a record so far as I know," said County Engineer King. "The construction of this road gave work to approximately 400 men and teams, 75 per cent of whom were farmers, and placed approximately \$60,000 in circulation within three months. Every cent of this money was paid to men living in Labette County.

"In October, 1921, I prepared an estimate for graveling this section of the project and arrangements were made with the state highway commission and the federal government to allow the county to do this work by force account or day labor. My estimate was \$5,154 per mile, 50 per cent of which was to be paid by the federal government."

The road which was built is known as Section "C" of Federal Aid Project No. 2, and it lies between Oswego and Altamont. The No. 2 Project consists of about 45 miles of gravel road in all, Section "C" making up a 10.52 mile block of the system.

"On December 5th the county's forces began placing gravel on this road by day labor," stated Mr. King, "using all local men and teams, paying 30 cents per yard



The teams on the job in Labette County where the farmers worked out their taxes in record time, averaging 300 loads a day.

The Highway Magazine

per mile for hauling the gravel and 15 cents per cubic yard for loading the gravel. Each man loaded his own load by hand, using an ordinary shovel. The work was completed February 20, 1922, or in 43 actual working days.

"The average number of loads hauled in a day and placed on the road was 300. A total of 12,900 loads were placed in the 43 days. This amounted to 20,055 cubic yards of gravel. The best day's run was 530 loads or 980 cubic yards. On this day 2,740 lineal feet of road were laid. This was 100 feet over one-half mile. The gravel was hauled 5 miles at this particular time, and 350 teams were at work on that day.

"A summary of the total cost of this work is as follows:

Hauling gravel	\$46,533.43
Loading gravel	3,008.25
Forming, spreading, harrowing.....	1,918.58
Gravel bar, stripping, plowing.....	940.24
Dragging and preparing sub-grade.....	129.71
Building road to gravel bar.....	390.26
Cost of right of way to bar.....	200.00
Lumber for forms.....	125.92
Blacksmithing, pins, etc.....	153.05
Hardware, shovels, etc.....	17.00
Stakes	16.00
Cost of field gravel.....	298.77
Printing	147.00
Resident engineer	600.00
Total	\$54,481.91

"This is a cost of 54½ cents per square yard for the finished feather edge gravel road, 16 feet wide. The loose gravel was placed on the road between commercial two-by-ten planks, 13 feet apart which, when harrowed, graded and compacted, give a 16-foot gravel road.

"The cost of building various sections of this same road varied materially. Section 'A' with an average haul of 3.5 miles cost 58 cents a square yard. Section 'B' with the same average haul cost 87 cents, while Section 'C,' the one under discussion here, cost only 54½ cents a square yard. The first section was completed in



This culvert of Armco ingot iron is giving excellent service, in spite of the erosion of the road due to faulty fill.

two years, the second in 2½ years and Section 'C' in 15 months from the time the grading and bridge work was started until the gravel was down and ready for service.

"A number of the farmers were able to earn more than their tax amounted to, and all of them were able to materially reduce their tax by offering their labor at a time when they could best afford to do so."

Motor Vehicles and Road Expenditures in 1904 and 1922

MOTOR vehicles registered in the United States in 1904 totaled 94,000. In 1922 its registration was 10,620,000. In 1904 the expenditures on roads amounted to \$59,527,000. In 1922 some \$775,000,000 was spent on roads.



Reclaiming a River Road in Idaho

By ERNEST F. AYRES

Special Correspondent for The Highway Magazine

The Clearwater River washed out an important road. Twenty thousand dollars; a few thousand pounds of dynamite; combined with good engineering practice, reclaimed the road bed.

THE highway engineer in the older, more densely settled states, has a comparatively easy time of it, even though he fails to realize his blessings. The old road, built away back in grandfather's time, furnished him with a ready-made location, although it rarely matches his conception of the ideal. The oldest inhabitant can give him all the information he needs to determine the size of his culverts, so all the lucky S. I. has to bother with is the type of surfacing to use. As every paving concern stands ready to give him free advice on this point, "he should worry."

Out West, where mountain and canyon determine the only possible location of a new highway, the engineer's status is no joke. Northern Idaho furnishes him with real thrills, though a choice of surfacing rarely enters into his problem. Everyone knows that his funds will be exhausted before the grading is completed. He can



Where the road must be built.



The same location after blasting and grading had begun.



The completed highway.

soothe his perturbed soul by gazing upon the magnificent scenery until he realizes that this very grandeur, mixed up with his work, is the cause of nine-tenths of his troubles.

The scenery tangled with a county road in one of the canyons of the Clearwater river a few years ago, and the highway came off a poor second. The old trail between Kooskia and Stites had followed the river's edge for a generation. Then one spring, when the snow all tried to leave the mountains at the same time, a section of highway around the bluffs left its proper resting place and traveled down stream "muy pronto." It may be in the Pacific Ocean by now. At any rate, it never came back.

The inhabitants of the country, being of a philosophical turn of mind, opened a new road back from the river, five miles longer than the old route. Then they sat down and waited in peaceful contemplation for the time when the state highway would come along and rebuild the old short cut. The state might be big enough to fight the Clearwater river; the county knew when it had had enough.

This year the state accepted the challenge, and awarded a contract to Sam Boudrye in March. Only 1.10 miles of grading were covered by the contract, but it cost a trifle over \$20,000, most of which

was spent in about 1,500 feet at the foot of the bluffs. Like the famous Crow's Nest highway back of West Point, the road had to be blasted out of solid rock. The New York engineers, however, had solid ground to build on. The Idaho engineers robbed the river.

But the old Clearwater had done a good job in that old-time freshet. Not content with digging a hole in the road, it had taken the whole business, and had dug itself a nice, deep channel clear to the solid rock of the ledges. The engineers decided that two could play at that game. As the river had deliberately stolen its present channel, so would they steal from the river to build their highway.

The tops of the bluffs were shot into the water, and the Clearwater, finding too many stones in its bed, moved over where it belonged. No wonder, for a single shot brought down 12,000 cubic yards of rock, using 7,000 pounds of 40 per cent dynamite. Like all big rock work, this was worked from the regulation big hole, called a "Coyote" on this job. It seems to have a different name in every locality. Some call it a "Grizzly," some a "Jack Rabbit," but the title which is probably best known to hard rock men is "Glory Hole."

The ledges themselves seemed to enter into the spirit of this joke on the Clearwater, for they gave up their rock in nice small pieces, and the muck piles were easy to handle. It proved to be no trick at all to get a good shelf built into the cliffs and to spread the material to the new grade. Even the surrounding country was kind, forming its topography so that no culverts had to be installed in the ledge. Corrugated iron pipe was used for all drainage, but fortunately these could be placed at both ends of the bluffs where there was good, easy digging.

The highway is completed, and the river has been harnessed with heavy rip rap. So far, the road builders have won. The Clearwater flows peacefully in its narrowed channel, but will it always consent to this imposture? Will the rip rap hold when the spring waters come tearing down to join their sisters in the big Snake, or will the river laugh, pick up the new highway and carry it along on its tumbling journey? Who can tell?

Landscape Architecture on the Lincoln Highway

By JENS JENSEN,
Landscape Architect

Jens Jensen, "interpreter of the landscape's soul," and called one of the ten most useful men in a city of three million, tells how the Ideal Section of the Lincoln Highway is being made beautiful as well as useful.

SEVERAL years ago the American Institute of Architects appointed a committee to work in conjunction with the Lincoln Highway Association for a comprehensive plan of the Lincoln Highway from coast to coast. As a member of this committee, I was later asked by the Chairman of the Conservation Committee of the General Federation of Woman's Clubs to work out a scheme that could be followed throughout the different states as a plan for the Lincoln Highway. My suggestions were approved by the Chairman of the committee and later endorsed by the General Federation at its bi-annual meeting.

The plan, in short, asked for a right-of-way of one hundred and seventy-five feet, with a seventy-five foot roadway and fifty foot parkways on each side. There were suggestions for markers at state lines and at the boundaries of towns and villages, and places for rest stations and drinking water facilities in such sections where the distance between towns was too great for ordinary comfort. The plan suggested using native material indigenous to the region for planting in the parkways, using groups of the most dominant tree of the state to note the intersections of main cross roads.

It was very soon after this that the Illinois Federation of Woman's Clubs requested me to make a plan for the Lincoln Highway through Illinois. Such a plan, however, could only give general directions as complete surveys of the counties through which the highway went were not obtainable. County maps were consulted and the most important changes in topography and soil learned by visits to those regions. The plan followed the suggestions adopted by the General Federation. The planting plan was prepared in sections to fit the different types of landscape, as for instance, a section for the open prairie. Here only such plants were to be used that would not shut out



JENS JENSEN, Landscape Architect.
Photo courtesy Paul Wright

the broad outline of our prairie country. The white oak being the most dominant tree in Illinois in strength and character was assigned to decorate the intersections of main cross roads; these groves of trees will appear as oases on the prairie sea—like our farmsteads in the apple orchard. Where the road went through forests, the parkway was left as part of the forest and where it went through swamps, swamp vegetation was the key note. In that way the characteristics of the country were preserved and emphasized by using such planting material that by its flowers and beauty of form brought out the best of our native landscape.

The Ideal Section of the Lincoln Highway, now nearing completion in northeastern Indiana, has followed, as far as it



Laying reinforced concrete on the Ideal Section of the Lincoln Highway

has been possible, this general plan set forth above. True, the present right-of-way is only one hundred feet with an option on an additional twenty-five feet. The pavement is forty feet but can be widened whenever the traffic should demand it. The highway goes through Dune country bordered by what formerly consisted of large swampy lands, now rich corn fields. For picturesqueness, this section is equal to any in that region. A little stream adds interest to the landscape. The Dunes are covered with a growth which largely consists of red oak, fringed with fine groves of our western crabapple. The lowlands consist of open wood and corn fields. The soil is of a sandy nature, richer in the lowlands than on the higher elevations.

In working out the plan for the parkways, there was one serious obstacle to be encountered—the telephone and telegraph wires that lined either side of the roadway. Attempts made to have the wires put under ground were met with defeat. It was finally agreed to place the wires on one side of the road just inside of the right-of-way. Where these wires go through the wooded areas, they are very little in evidence, but in the open country they must be considered as an obstruction.

The plan as developed by the engineers demanded a lighting system of the most efficient kind. This again had its drawback as efficiency and art do not always hitch, but efficient lighting had to be, and some sort of a standard having some degree of refinement in its design had to be made. One sometimes shudders with

horror at the time when the world is all brilliantly lit up; when the opportunity for the poor slaves of mortal beings to see the poetic light of the moon and the glorious starlit heavens will become a thing of the past.

The vegetation selected for the parkways is of the same type as found native in that region and indigenous to the soil; this beforehand assures success. Where the land is forested, the idea of the forest was to extend into the parkway and where it is open, only such vegetation was to be used that would not shut out the view of the open country.

Now in planting the parkways along the Lincoln Highway, all the plants native to that region are not used. It is not a matter of making an arboretum out of the parkways, but of creating as much beauty as possible by using such plants that more than any of the other plants of the region express the greatest beauty. I want to further state that it is not a matter of copying nature, but of working out a picture, the motive of which is our native landscape. Accordingly, there are groups of plums that illuminate the dark forest border in early spring; there are the lovely pink crabapple blossoms and the white hawthornes to brighten the days of May; and there are roses for June, with a great many perennials for the rest of the season, finishing off with late asters and golden rods when Frost throws his white veil over the last of its type.

The whole scheme is a simple one, but it is a fitting one and fitness is essential in all works of art.



The 40-foot pavement on the Ideal Section.

Irrigation and Drainage

Warmsprings Project Shows Low Maintenance Cost on Metal Flume

Ease of removability of flume during winter months aids in cutting down spring repair bill due to ice damage.



One of the Armco ingot iron flumes on the Warmsprings Project.

FOR the past four years the manager of the Warmsprings Irrigation District of Vale, Oregon, has been gathering data on the maintenance costs of metal and wooden flume used on the Warmsprings project.

In 1919, 15 Armco ingot iron flumes were installed, replacing old wooden flumes on which the maintenance cost had become prohibitive.

These flumes varied in length from 24 to 40 feet, and in size from No. 60 to No. 120, the latter size carrying more than 200 second feet of water for the past four irrigation seasons.

Mr. Charles L. Batchelder, manager of the Warmsprings District, states that this large size flume shows a 100 per cent maintenance record, never having had a cent charged to it for upkeep and is still in perfect condition showing no leaks or signs of deterioration.

Mr. Batchelder further says: "The only maintenance expense on the metal flume has been a few pounds of asphalt put in the joints in the spring before turning in the water. This is a very inexpensive operation and does not cost to exceed \$5 for any of the flumes. I have had this done only on flumes that are so located that we cannot take a chance with a slight leakage, as the footings might be washed out."

An added feature in the keeping down of maintenance costs is the removability of this type of flume. The old wooden flume suffered severe damage from ice during the winter months and necessitated rather extensive repairs each spring. Four of the Armco flumes averaging 40 feet each in length are so located that they have to be removed each fall to protect them from winter damage due to ice running in the channels. These flumes are removed in two days by two men.

Intensive Development of Colorado Ranch Due to Model Irrigation Structures

By LYMAN E. BISHOP

Consulting Engineer, Denver, Colorado

SOME 600 acres of land on the Williams River, in Moffat County, a few miles south of Craig, Colorado, were recently purchased by C. A. Fisher, a consulting geologist, of Denver, with the idea of intensive development by modern methods of irrigation. This land extends along the river for about four miles and has, for the past forty years, been operated as a cattle ranch. Approximately 250 acres are irrigable bottom lands along the river, where native hay has been cultivated and irrigated in a more or less desultory way. The irrigation system that was available for these lands was of the primitive pioneer type and included two rock and brush dams on the Williams River which on several occasions were washed out by the spring floods. These old dams were rebuilt, repaired or neglected each year as the owner chose.

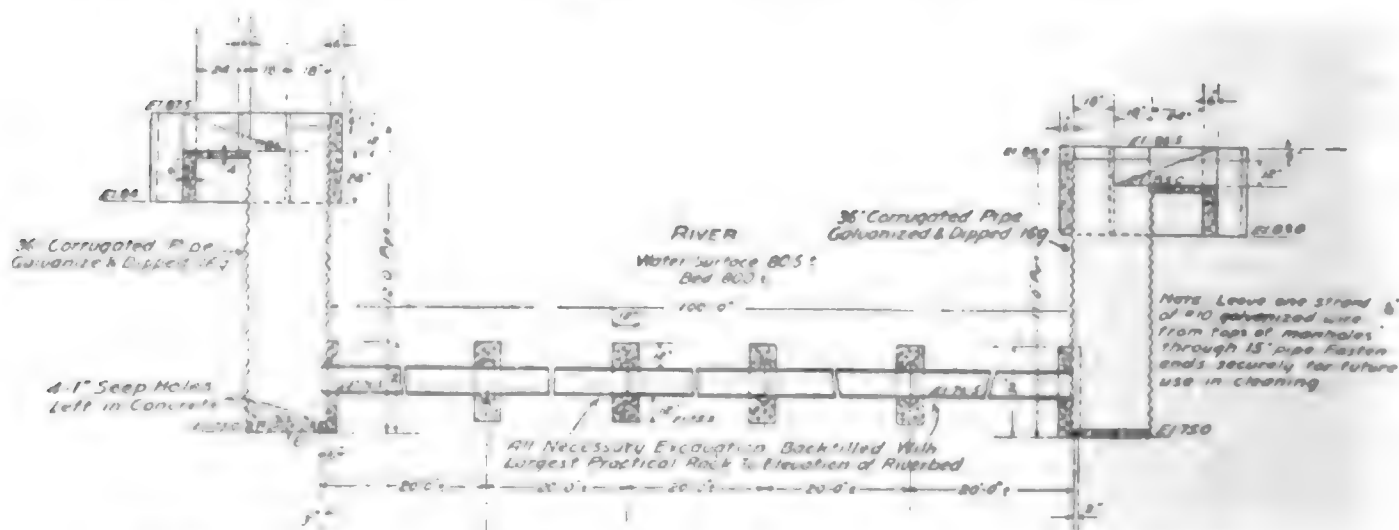
As the present owner has decided to develop this property intensively, plans have been made for four farms of approximately 150 acres each, 60 acres of which will be irrigated. Each of these four farms will have a complete set of modern improvements and equipment and are to be operated by lessees as intensive dairy farms with allied diversified farming operations in addition.

As part of the development program it

was decided early in September, 1922, to reconstruct the old irrigation system and install permanent structures for its future operation. The old system had two diversion dams and two headgates, located approximately 1.5 miles apart on the river, and two ditches serving the land. The bottom, or irrigable land, is practically all on the east side of the Williams River, and on the upper half of the property. At about the middle of the property, the river swings across this bottom land and hugs the east foothills and here the irrigable land is all on the west side of the river.

The new irrigation system has one diversion dam and one headgate on the east side of the river, both located near the site of the upper old diversion dam. The two old main ditches are to be enlarged and used in their present location as a part of the reconstructed irrigation system. At approximately the center of the property a metal pipe syphon crosses the river and connects the east side upper ditch with the west side lower ditch. This syphon structure takes the place of the old lower diversion dam and headgate.

The field surveys for the proposed construction of the new diversion dam, headgate and syphon were started on September 9, 1922. Plans, specifications and contract and estimates for the proposed construction were available on September



Plan of the syphon under Williams River described in the accompanying article.

20th. The work was advertised for bids from September 24th to October 2nd and the contract was let to the successful bidder on October 3rd. The construction of the diversion dam, headgate and syphon was completed and the structures were ready for operation on December 9, 1922, exactly three months after inception.

A study of the fifteen years of daily discharge records available of the Williams River, near the site of the Fisher dam, disclosed the maximum average 24-hour flood recorded to be 3,870 cubic feet per second and the maximum, or peak rate, of discharge of this flood to be 4,250 cubic feet per second. This maximum, and all

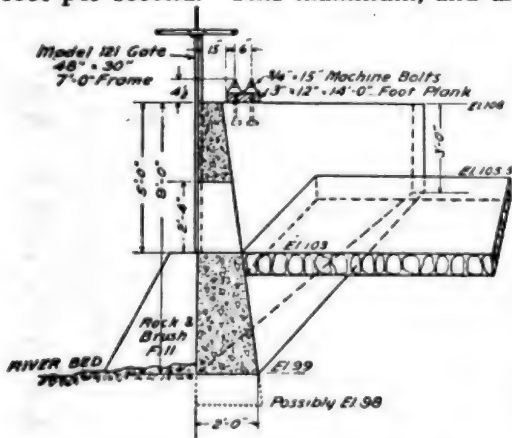


View of Fisher Diversion Dam on Williams River, taken from West abutment.

second. The Williams River during August and September at the Fisher diversion dam often has a discharge of only 25 to 30 cubic feet per second. With the adopted grade of the bottom of the Fisher ditch at the headgate of 3.0 feet above the bed of the river and a depth of water in the ditch of 1.5 feet it is necessary during low water to raise the water surface in the river approximately 4.5 feet.

An unusually interesting engineering problem was presented for solution with the existing conditions: A small ditch, serving only 250 acres of land; a diversion dam that must pass 7,300 second feet safely, and yet during low water period must raise the river some 4.5 feet; the cost of this construction to be assessed against 600 acres of property, of which only 250 acres are irrigable.

Several different types of diversion dams were considered, designed and their cost estimated. The final type adopted, as being the most adequate to meet all



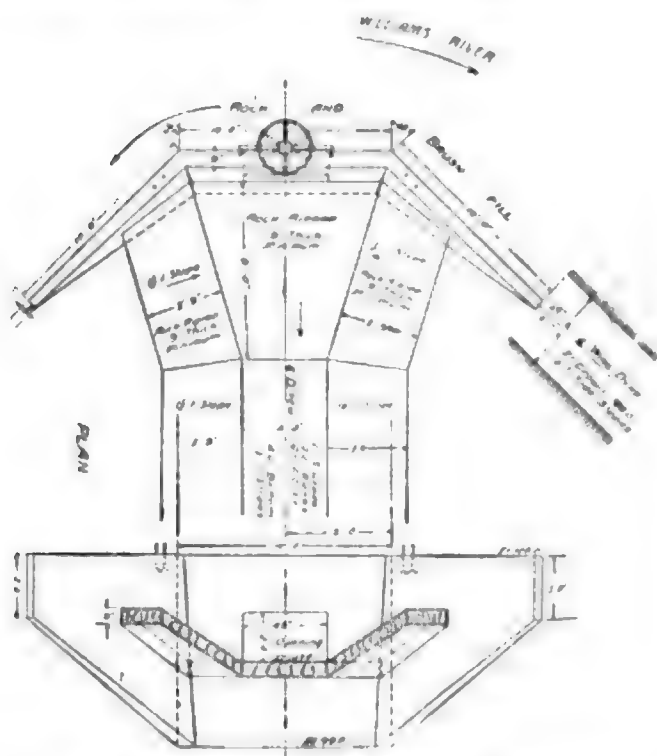
SECTION ON CENTER LINE
Longitudinal Section of Headgate at
Fisher Diversion Dam.

other yearly maximum 24-hour floods, are due to melting snows. The drainage area above the Fisher dam is 414 square miles and the altitude varies from 6,500 to 10,500 feet above sea level. The maximum yearly 24-hour floods occur generally each year between May 15th and June 5th. The main and direct factor affecting the flood flows is the preceding prevailing temperatures over the snow covered drainage area. A careful and detailed study and analysis of existing discharge records was made and from this analysis it was concluded that the probable maximum average 24-hour flood to be expected at the Fisher diversion dam was 5,430 cubic feet per second and the probable maximum or peak rate of discharge of this flood would be 7,335 cubic feet per second.

The proposed capacity of the Fisher ditch at its headgate is 15 cubic feet per



The Fisher Headgate. Rock and brush bank protection work in progress.



Plan and section of ditch at headgate.

existing conditions, consists of eleven concrete jack piers spaced on 7.5 foot centers between concrete abutments 88.5 feet apart. The tops of the abutments are 8.0 feet above average river bed and the tops of the jack piers are 5.0 feet above average river bed. Between adjacent jack piers a concrete cutoff wall extends from the average river bed to a depth of three feet. From the bottom of this concrete cutoff wall, and tied into this wall, Wakefield sheet piling of three 2 inch by 8 inch native spruce, extends to a depth of 5.0 feet or 8.0 feet below average river bed. There were 4,093 pounds of structural steel—ice buffers, flash board guides, etc., used in the diversion dam.

The accompanying photographs of the Fisher diversion dam were taken in December, 1922, and show the completed structure. The footwalk on top of the jack piers is removable. Each opening between jack piers may be closed by flash boards if desired to a height of 4 ft. 7 in. Each of these flash boards is 6 ft. 5 in. long, 5.5 in. wide and 2.5 in. thick and are of No. 1, Clear Douglas Fir. The plan of operation of this structure contemplates the removal of the footwalk and all of the flash boards in the fall so that the dam will then be ready to handle the spring ice and flood flows. When the flood flows are passed, the footwalk will be replaced and the desired elevation of the river water surface controlled and

regulated during the balance of the season by means of the flash boards.

The accompanying photograph of the Fisher headgate was taken in December, 1922. The structure is of concrete with one, 48-inch wide by 30-inch high, steel gate. The headgate is located in a bend of the Williams River, about 300 feet upstream from the Fisher diversion dam. The nearly vertical earth bank of the river is protected with rock and brush fill for a distance of 90 feet adjoining the headgate. This rock and brush fill is 3.0 feet wide on top and the front slope is 0.5 to 1.0. The placing of this rock and brush fill was still under way when the accompanying photograph was taken and when completed the top of the fill extends to the top of the concrete headgate walls.

A rather unique design was adopted for the Fisher syphon crossing of the Williams river. This structure consists essentially of two 36-inch diameter, corrugated Armco ingot iron pipe manholes or penstocks, 103 feet apart, one on each bank of the river. Connecting these penstocks is a 15-inch diameter, 14-gage, riveted Armco ingot iron pipe, galvanized and dipped. The top of this 15-inch pipe is 2.0 feet below the lowest point in the river bed at the syphon crossing. Four square concrete collars at the 15-inch pipe joints, 20 feet apart, extend a minimum of 12 inches outside the pipe. Silt basins are provided at the bottom of the penstocks. Near the top of the penstocks, at the bottom of the ditch, screen trash covers are provided. This screen is made of No. 8 wire and of 1.0 inch mesh.

Complete costs are available of this construction work and the following table summarizes these data:

	Dam	Headgate	Syphon	Total
Engineering				
Surveys, plans, contract and specifications ..				\$ 533.33
Supervision of construction				889.57
Total engineering				\$1,422.90
Construction				
Materials, steel pipe, cement, etc.....	\$1,013.60	\$136.98	\$391.39	\$1,541.97
Contractor, work and material	2,343.89	601.72	485.39	3,431.00
Total construction.....	\$3,357.49	\$738.70	\$876.78	\$4,972.97
Total cost engineering and construction.....				\$6,395.87

The writer prepared the plans, specifications and contract and acted as Chief Engineer during construction. Frank M. Drescher, Civil Engineer, of Craig, Colorado, acted as Resident Engineer.

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In 1913 this twin 24-inch Armco Culvert was installed under a busy double track railroad system in New York State. Today, after eight years of good and bad weather, vibration and heavy loads, both culverts are in perfect condition.

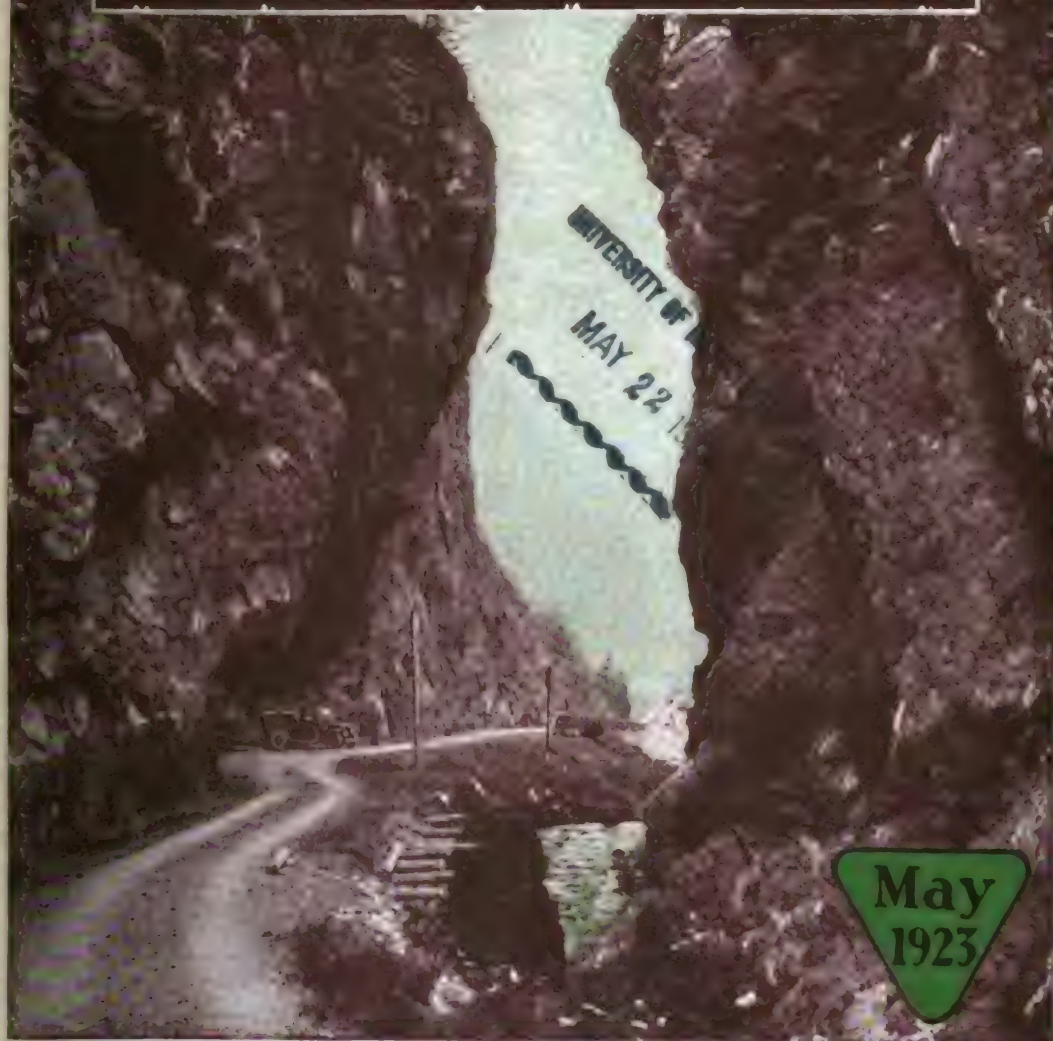
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The HIGHWAY MAGAZINE



Cutting A Road Through the Canadian Rockies—
The Banff-Windermere Highway

See page 3

**Write to the nearest manufacturers for particulars
and prices on ARMCO (American
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Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Illinois, Springfield
Illinois Corrugated Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equipment Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
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The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIV.

MAY, 1923

No. 4



Railroad Transportation in the Days of '49

Pictured above is the old "Collis P. Huntington," the first locomotive operated on California's pioneer railroad. It was shipped around the Horn and was once the pride of the Southern Pacific. In the cab is John Lonegran, driving the ancient locomotive at the recent California celebration of the "Days of '49," just as he did in the olden days.

At the left can be seen three transportation pioneers—the men who ran the old engine shown above. Reading from left to right: Stephen Uren, the first shopman; Thos. O'Connell, the first fireman; and John Lonegran, the first engineer. Lonegran is no longer an engineer, but a Philadelphia millionaire.



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CHAS. B. CORY, Jr.....Managing Editor
FRANK E. KENNEDY.....Associate Editor
LOUIS A. GRAHAM, M.E...Consulting Editor

Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Prize Winning Stories to be Published Next Month

Watch for the prize winning articles in "The Road Past Your Door" High School Contest which will appear in the June issue of Highway Magazine.

The wonderful response which followed the announcement of "The Road Past Your Door" Contest, open to the High School students of the United States and Canada, reveals the fact that there is a very definite and universal "good roads consciousness" in the ranks of the high school students of America.

Hundreds of manuscripts have been received by the editors. Many more students wrote articles which were not received at the editorial office owing to the fact that many high schools conducted preliminary elimination contests under the supervision of the principal or the teachers of English and Civics, and only the best stories written in the class exercises were entered in the contest.

The prize winning stories together with the names of the winners are now in the hands of the printer and will appear in the next issue of Highway Magazine.

Federal Aid for South Carolina Roads

At a meeting of the State Highway Commission, Federal Aid totaling nearly \$900,000 was appropriated to various counties for road and bridge construction.

Foundations for Road Pavements

FLEXIBLE foundations, says Mr. H. W. Skidmore, English highway authority, include gravel, broken stone, water-bound macadam, bituminous macadam, and hot-mix bituminous concrete. They are usually classified as to value in a pavement structure in reverse of the order named, with bituminous concrete as the highest type. It is estimated that there are 15,000,000 square yards of "black base" giving satisfactory service in England. The bituminous foundation structure, although possessing considerable beam strength, functions primarily as a shock reducer, that is, it gives slightly under the blow of impact in transmitting the load to the subgrade. Its use, then, is dependent upon a knowledge of the ability of the subgrade to support loads equal to the probable force of impact reduced by the slab strength residing in the bituminous structure; whereas, the rigid type, regardless of the bearing power of the soil, must be built to sustain the entire force of impact. For this reason a much thicker rigid foundation is required under given traffic and subgrade conditions, as has been demonstrated by impact tests.

New Mexico to Pave Indian Roads

THE section of State highway from the foot of La Bajada Hill to Algodones will be paved in the near future, according to State Highway Engineer L. A. Gillett. The road, 24 miles long, will be paid for entirely by the government owing to the fact that it is located entirely across an Indian reservation.

Topographic Surveys in 1922

DURING the fiscal year ended June 30, 1922, the topographic branch of the U. S. Geological Survey surveyed more than 12,000 square miles of new area, exclusive of Alaska, and resurveyed approximately 1,500 square miles.

Cutting a Road Through the Canadian Rockies

By A. N. LONGSTAFF

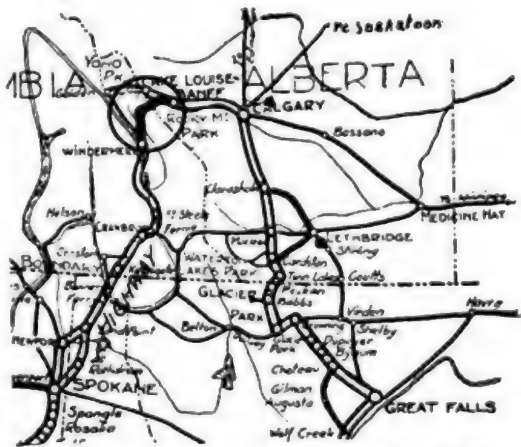
Special Correspondent for The Highway Magazine

The story of the construction of the Banff-Windermere Highway reveals a remarkable triumph of engineering skill and perseverance in the face of almost insurmountable difficulties and dangers.

HEWN through the heart of mountains; sliced from the edge of cliffs which overhang with a seeming threat of extinction for the mere human beings who would dare to venture beneath their frowning grandeur, creeping, ribbon-like, over stretches of almost level country between two mountain ranges, where huge firs and spruce rear their bulk on either side of the man-made road, climbs and winds the Banff-Windermere Highway, connecting link in the chain of good roads which makes possible an automobile tour through the heart of the Canadian Rockies.

The highway was built by the engineers of the Canadian National Parks Branch of the Federal Government. A. W. Campbell, who is Commissioner of Highways for the Dominion of Canada, and who is known internationally as "Good Roads Campbell," says: "It is a wonderful road and a wonderful achievement." Coming from Campbell that is praise indeed.

For years Canadians have talked of a road through the Rockies but seventy-three miles of virgin mountain and forest country, presented almost insuperable



On the above map, the heavy black line within the circle indicates the Banff-Windermere Highway.



A temporary wooden bridge on the Banff-Windermere Highway at Vermillion Crossing, Kootenay Park.



At the top of Sinclair Pass in Kootenay Park, 4,950 feet above sea level.

difficulties between the hope and its realization. Added to the difficulties of the country to be traversed, was the fact that work could be carried on only during a few months in each year.

The general route of the road is south-westerly from Banff, Alta., following in succession the valleys of four mountain rivers, namely, Bow, Vermillion, Kootenay and Sinclair Creek. It crosses the main range of the Rockies via the Vermillion Pass, which was explored by Sir James Hector in 1858, when, with the Palliser expedition he was seeking a route through these mountains for the Canadian Pacific Railway.

A western range of the Rockies, the Brisco range, is crossed by the Sinclair Pass. In the Vermillion Pass an altitude of 5660 feet is reached and over the Sinclair Pass the road climbs to an altitude of 4950 feet. On its westerly course, in reaching these two passes, the highway climbs a total of 2626 feet and descends a total of 4205 feet. Despite this great rise and fall in elevation, however, the grades obtained are remarkably low, the maximum being some four hundred feet of nine per cent grade, with an average grade of three per cent.

The total length of the road is 93 miles, of which the 30 miles lying in Rocky

Mountain Park had been constructed by the Dominion Government some years previously. The Province of British Columbia had also built 10 miles of the road in that province. Construction of the uncompleted 53 miles in British Columbia was begun by the Parks Branch in the fall of 1919 under an agreement which called for completion by January, 1924. The uncompleted mileage comprised chiefly the middle section of the road between the two summits.

Now the road is complete, and will be formally opened to traffic on June 30 of the present year.

No railroad lines were available for transportation, and all equipment and supplies had to be transported to the location of the work from the east or west ends of the existing roads. The average haul from each end was 35 miles which included the passing over of one of the mountain summits. This transportation problem was successfully overcome by the use of six three-quarter ton trucks which hauled all supplies during the summer months. These trucks averaged about 100 miles per day, very often including two return trips over either the Sinclair or Vermillion Pass.

Due to the location of the work, favorable conditions for grading operations prevailed for only four months each year. A high rate of progress had consequently to be maintained during the working season. In order to utilize all the summer months on grading and to lessen the danger of fire in the heavily timbered areas traversed, clearing work was carried on during the winter. Fighting heavy snow-falls of from four to five feet along the route of the road and keeping open "tote" roads for some 60 miles under these conditions in order to serve the clearing camps were among the difficulties met with in carrying out this work.

At the same time as right of way clearing was in progress the necessary bridge work was done, which included eight truss bridges and several small bridges. Grading operations in the summer months practically kept pace with the winter clearing work. The latter was completed in the spring of 1922.

In 1921, 26 and one-half miles of new road were graded and the completion of another 17 miles in 1922 saw the work

finished by September, a year and a half ahead of the agreed time. In the nine months actually devoted to grading operations in 1921 and 1922, 43 miles of road were built through mountainous country.

A standard width of road, providing a 16-foot clear wheelway, was adopted, which, with an allowance for ditching, gives a 20-foot base in cuts. All curves are superelevated and given an extra width.

Surfacing of the road with screened gravel was begun in 1922, 20 miles being completed. The heaviest construction, which included solid rock cuts from 40 to 50 feet high, cost \$27,000 per mile, while the average cost of the road built by the Parks Branch was \$7,700 per mile.

J. M. Wardle, B. Sc., C. E., A.M.E.I.E., Chief Engineer of Canadian National Parks Branch, Department of the Interior, was the man who carried the thing through to a successful conclusion, opening up both to Canadian and American tourists a vista of scenic wonderland, the equal of which it would be hard to find anywhere in the world.

The completed highway traverses deep-hewn valleys "plumb full of hush to the brim;" cuts through cliffs towering above to right and left, beside which man and his handiwork seem but pigmy



J. M. Wardle



Road construction gang at work near McLeod Meadows, Kootenay Park.

things of perhaps a dream age, and borders lakes, wondrous in their depth and purity, mirroring back the mountains which overhang them. In this wilderness Rocky Mountain sheep and goats stand on the qui vive, in the roadway or perch on crags far beyond reach, wondering at this new intrusion of man. Such is the Banff-Windermere Highway, completing link in a chain of roads which make possible a motor tour from Los Angeles along the

Bee-Line Highway, through the American and Canadian National Parks and around a loop which covers parts of seven States and two Canadian provinces.

On June 30 Hon. Charles Stewart, Minister of the Interior of Canada, under whose administration the Parks Branch lies, will cut the ribbon and declare the road open to traffic. Representatives of both countries will be present and the day will be a red-letter day in the tourist traffic history of both countries.

• • • • •

Millions to Be Spent In Idaho

THE road construction program in the State of Idaho for the year 1923 will involve the expenditure of approximately \$5,000,000 on the State system, including Federal Aid appropriations.



Wild mountain sheep and goats are often seen along the Banff-Windermere Highway.

Solving the Surface Drainage Problem of a Georgia Highway

How corrugated iron culvert pipe provides surface drainage and prevents soil erosion of side embankments on a paved highway in Fulton County, Georgia.



The catch basin described in the accompanying article and diagrammed below, is shown at right in the photograph.

A UNIQUE culvert installation, designed to take care of the surface drainage on a paved highway in Fulton County, Georgia, and at the same time prevent soil erosion on the steep banks flanking the highway, is still giving perfect service after having been installed more than nine years.

The culvert used was a 14-gauge, 72-inch Armco corrugated culvert, 56 feet in length. It was installed under a paved road in 1914. Catch basins of rubble masonry were built which rested directly on the culvert through which a square hole had been cut to receive the water

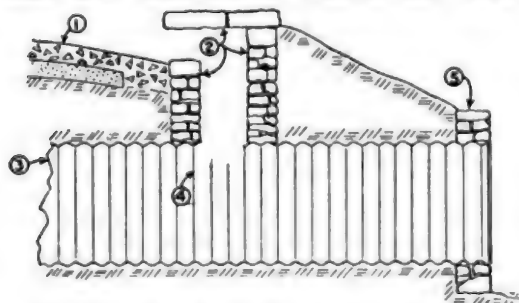
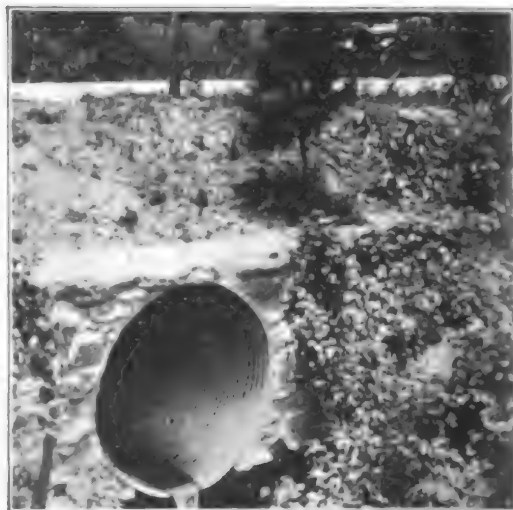


Diagram of culvert installation. 1, Highway pavement. 2, Rubble masonry catch basin. 3, Armco corrugated culvert. 4, Hole cut in culvert to admit water from catch basin. 5, Culvert headwall.

from the catch basins. The photograph at the top of the page shows one of the catch basins. The accompanying diagram illustrates the manner in which the installation was made.

A recent inspection of this nine-year-old installation revealed no sign of rust on the corrugated iron. The points in the culvert on which the heavy rubble masonry catch basins rest showed no deflection whatever, and the places where the square holes had been cut through the metal were bright and new—almost as new as the day the culvert was in-



Outlet end of Armco culvert showing head-wall and steep side embankment.

stalled—there being no red tinge or other evidences of rust visible.

This installation, for all practical purposes, is positively as good today as when installed nine years ago, and it was on the basis of service rendered by this installation and other old installations in the County, dating back as far as 1909, that the Fulton County Board of Public Works decided to use Armco corrugated culverts freely in their present road building program.



Photograph No. 2. Showing the method used in checking up the crown of the road.
See page 9.

Field Testing of Pavements in Illinois

By H. F. CLEMMER

Engineer of Tests, Illinois Division of Highways

Laboratory tests and analyses are playing an important part in the scientific determination of what is actually in the pavement after it has been completed. Read what the Illinois State Highway Department is doing to produce better pavements.

THOUGH no state in the Union can boast of a more rigid inspection of road construction than Illinois, still this inspection has not been considered sufficient proof that the resulting road is perfect, and testing of pavements after completion of construction is coming into use more and more in this State. This testing of roads is not to be considered in the light of an investigation to determine whether the State has been defrauded in value received but rather should be looked upon as the only logical method of checking up on jobs with the idea in mind of bettering future construction. That the state of Illinois is sincere in the statement that it has confidence in its contractors is evidenced by the fact that there is no provision in the specifications which insists upon the development of a certain standard compressive strength, and that the majority of roads are being accepted for payment previous to being tested.

Complete reliance is placed in the resi-

dent engineers to govern construction so that all the conditions affecting proper work are carried out satisfactorily. The preparation of the subgrade, the mix of the batch, the finish of the surface, the inspection of all aggregates and other important factors in good construction are efficiently controlled by state engineers. These conditions being carefully governed, it would seem that a fairly uniform strength and thickness of pavements would result. This, however, is not the case. The compressive strengths of the pavements vary as much as 4,000 pounds per square inch. Thicknesses of some of the standard pavements vary as much as an inch from that specified. It is evident, then, that in spite of the most careful inspection of construction operations the testing of the road after its completion, when it is in the condition to receive traffic, is absolutely the only method which can determine exactly what is in a pavement.

Illinois realized this fact several years



Photograph No. 1. Showing how the core drill is mounted on a truck ready for use.

ago and purchased a core drill with which to make observations. At the time of purchase it was felt that an apparatus which would allow the securing of slabs for cross bending tests would perhaps furnish better information than compressive strength specimens, due to the fact that the Illinois design depends on transverse strength rather than compressive strength for supporting traffic. This is explained when the present pavement section of Illinois is considered as being designed as a cantilevered slab, support being secured at the center with the edges free from the subgrade. This condition of little or no support at the edges is apparent during various changes of temperature and also in the spring and fall of the year when the subgrade is saturated with moisture.

A slab cutting apparatus, however, was unavailable and would probably have been impractical due to the fact that some of the specimens should necessarily be taken from within the slab. The core drill allows the securing of specimens anywhere in the slab with no resulting damage to the adjacent pavement. Furthermore, considering that a general relationship exists between the compressive and flexural strengths of concrete, the compressive strength of a core would give an indication of the transverse strength of the pavement. For this reason the core drill apparatus was chosen and very satisfactory results have been secured with its usage.

The majority of highway engineers are

familiar with the operation of the core drill, but for the benefit of those who are not acquainted with its usage it might be well to explain how it functions. A steel cylinder acts as the bit, two slots at the end of the cylinder being fed with small steel shots. The cylinder is revolved by a 6 H. P. gasoline engine and is kept free from frictional heat by a small stream of water. Continual contact with the pavement is made by use of a wheel which screws the bit down. At the start of the drilling operation the sprung weight of the truck is jacked up in order to reduce vibration to a minimum. Photo No. 1 shows a general view of the core drill mounted on a truck. This particular outfit has travelled over the majority of the roads in the northern part of Illinois and has taken hundreds of cores from pavements.

At present Illinois has two core drill outfits operating over the state. One of these core drills was secured from the University of Illinois and the other is owned by the Highway Department. Only one man is necessary to handle the core drill, which travels from one district to another. Orders are given from both the Main Office and the District Offices.

Upon reporting at the district headquarters the operator is given instructions as to where cores are to be taken. On the average a core is taken every 500 feet down the pavement, the first one



Photograph No. 3. The core removed from the slab. The white fluid around the hole is a mixture of concrete dust and water.



A stretch of Illinois road between Peoria and Chillicothe. Federal Aid Project 5-C.

being taken about one foot from the edge, the next at the quarter point, the next about one foot from the center joint; continuing in this manner across the pavement. In some sections more cores are taken, the number depending upon whether special investigation is desired.

At the time the core is taken a check is made of the crown of the road, the object being to determine the correctness of the distribution of the concrete. This cross sectional observation is made on the slab in line with the position of the core. A straight edge having a level bubble and a movable leg is used in making these readings. The movable leg is placed at the edge of the pavement, the other end of the straight edge resting on the center line, and the straight edge is leveled up. Readings are taken from the bottom of the straight edge to the surface of the pavement at two foot intervals. Photo No. 2 shows the method used in checking up the crown of the road. At super-elevated curves computations are necessary to determine the proper readings. Observations are also taken at the edges of the pavement by digging into the shoulder and measuring the thickness of the slab with a ruler. Photo No. 3 shows the core removed from the slab. A white fluid is noticed around the core hole. This is the mixture of the concrete dust and water.

After the core is removed it is measured, numbered, located on a sketch and sent into the laboratory. Concrete plugs which are carried in the truck are used in filling up the hole made by the drill.

These plugs are grouted in place with mortar and are not noticeable.

When the cores are received in the laboratory they are carefully measured for diameter, capped with stiff cement paste to insure a uniform bearing and tested for compressive strength in a Riehle machine. After the strength is computed the data with the sketch are sent to the office of the district from which the cores were taken.

Labor is the greatest expense connected with this work. An outfit can take eight to twelve cores a day. About two pounds of shot are necessary to drill one core. This shot, known as Calyxite, costs seven cents a pound. The cost of the concrete plugs runs about four cents apiece, including labor. The total cost of the operation of taking the cores, placing the plugs, testing the cores for strength, express charges and labor will not run on the average over 90 cents per core. Considering the information obtained, this cost can not be said to be prohibitive.



A fine example of modern highway drainage. An Armco ingot iron culvert under a Federal-aid road in Nebraska.



Making Old Block Pavements Do Double Service.

By JOHN KLORER, City Engineer, New Orleans, La.

Resurfacing Poydras Street, New Orleans, with asphalt without disturbing the original pavement, which was composed of granite blocks averaging 10 inches in thickness.

THE stranger visiting New Orleans is often interested in the antiquated square granite block pavement in some of the streets of the old section of the city.

There is a popular impression that these blocks were brought over the seas from Belgium, but this is erroneous; the quarries of Maine and Massachusetts furnished practically all of these blocks, and they were brought to New Orleans in sailing vessels in the early fifties.

These granite blocks are approximately 12 inches wide, from 14 to 18 inches long, and with a usual depth of 10 inches. As can be readily appreciated, these old pavements hardly meet the requirements of modern traffic, and some of them are being salvaged in the manner indicated in the photograph.

The picture shows Poydras street, one of the busiest commercial streets in the city (originally paved with these granite blocks), being surfaced with refined Trinidad Lake asphalt two inches thick, laid on a close binder $1\frac{1}{2}$ inches thick. The old original pavement was not disturbed, except adjacent to the gutter bottoms, where it was necessary to make some adjustment in order to conform

with the omission of a previously existing open drain.

All depressions in the old granite block surface were corrected by filling with a close binder and hand-tamping same before spreading the binder course. This practice has been found more satisfactory than attempting to get a surface by re-seating any low blocks. On another portion of this same street that was surfaced with a sheet pavement, there has been considerable shoving of the smooth wearing surface, and this has been attributed to the fact that in recrowning the old granite block pavement, the positions that these old blocks had taken after years of traffic, were disturbed, and even after rolling with a twelve ton roller, they did not get the final bearing they assumed through subsequent heavy traffic.

City Regulates Shade Tree Planting

WHITE PLAINS, N. Y., has adopted an ordinance regulating the planting, maintenance and protection of shade trees planted or grown upon public highways or places. A Shade Tree Commission of three members has been appointed.

Snow Control on Idaho Roads

By BLISS MOORE

Maintenance Engineer, Idaho Bureau of Highways, State of Idaho

In the following article, Engineer Moore tells how Idaho handles its snow control problem by drift prevention, elevation and compaction on county roads.

PREVENTION rather than cure is the measure of success in highway maintenance just as it is in combating disease.

First, a thoughtful analysis of conditions is essential. Is your right-of-way at least three times the width of your traveled way? Are trees, willows, and all shrubbery growing on the windward side of the road kept cut back fifty feet from the highway? Is the roadway graded above the surrounding land? Have you avoided high ditch banks?

In a new location select the longest open season and avoid northern exposures



Using dog teams on the Y-P Highway. The man at the left is sitting on a road sign 8 feet from the ground.



Cutting through 30 feet of snow on the Oregon Short Line Railroad near Ashton, Idaho.

and cuts, also, if possible, locate the road with the prevailing winds.

Sections of road subject to drifting snow can be protected by portable snow fences placed fifty or sixty feet from the road when permanent ones are prohibited; also wind deflectors can be used in extreme cases to blow the snow from bad places. These are usually made of boards set at such an angle that the wind current is directed toward the section that is subject to drifting.

In one case a road between towns was closed to automobile travel two months



Compacting snow on Y-P Highway with a tractor and log chain.



A rotary snow plow fighting through deep drifts on the Yellowstone Line, Ashton, Idaho.

used, the cable being placed around the tree and the hook placed over the cable. This method soon wore the cable at the point where the hook worked on it. A hook with a roller in which the cable worked overcame this difficulty.

Compaction, rather than the removal of snow, seems to be the least expensive method of keeping highways open to traffic, and the most satisfactory method where the snowfall averages three or four feet on the level.

In the outlying districts, where travel is light and by sleigh only, the thing to do after the first heavy snowfall is to "break out" the road and stake it by placing a lath or willow every three or four hundred feet so that after the next

heavy storm the tracks can be found. This gives a good solid base, packed from the ground up. A 14-foot log chain looped from one runner to the other behind a sleigh will keep the high center cut down.

It sometimes becomes necessary when deep chuck holes have developed to scrape them full of snow and to pack them well. Also there are times during a spell of thawing weather that the traveled way will be left higher than the rest of the roadway. This condition can be overcome by the use of a disc harrow with the discs set nearly straight, which cuts and packs the snow, giving a solid surface for travel.

The greatest aid to auto traffic in this section of Idaho during the winter would be a law requiring that all sleighs be made 56 inches from center to center of the runners, which is the same as the standard auto gauge, then with a minimum amount of travel there would always be solid footing.

We have used quite successfully a large heavy shutter drag, 14 feet wide by 16 feet long, hitched close to the tractor, so as to lift the front end a little, with considerable weight on the rear end.

Where there is a great deal of snow it is imperative that traffic be kept on top of the snow. To bank the snow at the sides as is done when roads are plowed out, causes drifting later on that is difficult to open up.

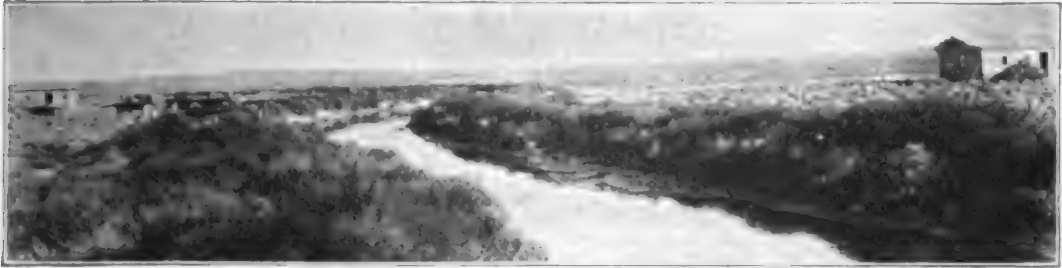


Compaction rather than removal is the method used in Idaho to keep the roads open. This heavy shutter drag, hitched close to the tractor and weighted on the rear end, made an ideal compactor for this purpose.

Irrigation and Drainage

Irrigation Facts Revealed by Uncle Sam

The past, present and future of irrigation in the United States, and its relation to increased production, and home building.



Bringing water to the thirsty but fertile sage brush lands of Idaho.

A TOTAL of approximately 20,000,000 acres of the waste lands of the west is fit for irrigation purposes, according to the United States Reclamation Service, and the eventual cultivation of this will add much to the productivity of the country. The figures released show that 2,000,000 acres are now being supplied with water from federal irrigation systems, which have been constructed during the last two decades.

Of this acreage, during 1922, 1,200,000 acres were cropped, with a gross production of \$50,000,000 for the year. A total of \$475,000,000 worth of crops was raised on irrigated land between 1906 and the end of 1921. These figures immediately become illuminating when contrasted with the cost of construction of the federal irrigation systems which is estimated at \$130,000,000.

It is to be expected that only the distant future will see all of the remaining acreage of public domain adequately checkered with irrigation canals and ditches, but it is taken for granted that the federal government will continue to build or at least to finance or help finance the major portion of the irrigation projects of the country.

The financing of governmental irrigation creates a problem, the solution of

which determines the speed with which additional construction can be carried on.

Taking into consideration the fact that it has cost \$130,000,000 to irrigate some 2,000,000 acres, and allowing a 50 per cent increase for the present cost of construction, it is estimated that the cost of irrigating the remainder of the public domain will be about \$2,000,000,000. If the reclamation fund, which is derived from sales of public land, royalties on the production of oil, etc., and repayment to



Ranch home of Dr. W. P. McPherson, who motored from New York City to Idaho in the outfit shown above.



Rust-resisting water-tight Armco ingot iron flume carrying water across a dry creek-bed on an irrigation project in the Northwest.

the fund by settlers, should amount to \$10,000,000 yearly, at this rate it would require 20 years to reclaim the remainder of the suitable waste land. In addition, it is to be noted that the contributions to the fund have decreased and there is little likelihood that \$10,000,000 a year will be available for some time to come.

At the present time \$20,000,000 worth of bonds have been provided to take care of the various projects now under way. These bonds are payable at the rate of \$1,000,000 yearly and this amount must be taken annually from the reclamation fund.

All of this indicates that it will require time for the development of the western lands to their maximum of productivity, but in the meantime federal construction is going ahead steadily. It has been pointed out that the arguments for additional governmental irrigation activity must be based primarily, not on immediate financial gain, but on the larger and more compelling needs of the country for homes.

The plan of national reclamation is unique, in that it provides for the return of the investment of federal funds by the beneficiaries. In other words, the government is the creditor and the farmer is the debtor. In times of prosperity the

collections are easily made, but in a period of depression the farmers are hard pressed to make payment.

The Congressional Relief Act approved on March 31, 1922, authorized the extension of time for the payment of construction cost, and payment for measures such as these must, of course, be taken from the reclamation fund.

Many authorities urge that loans should be made to help the settlers prepare the land for cultivation, put up buildings and buy tools and live stock. This also necessitates an increase in the money appropriated for irrigation.

Although it has been busy with its own irrigation systems, the government has done everything possible to aid private irrigation projects by furnishing topographic surveys, water measurements, grants to states under the Carey Act and in numerous other ways.

The government, cognizant of the need for many more small self-sustaining farm homes and realizing that the prairie plow lands are all being utilized, maintains a skilled body of engineers under whose direction and planning the present and future irrigation projects are worked out. It is to the engineer that the nation must look for the overcoming of the obstacles to irrigation which nature has imposed.

Building a Floating Weir-Type Dam on the Gila River

Unique construction methods overcome the problem of porous foundations, flood dangers, labor difficulties, and the cost factor on the Florence Diversion Dam in Arizona.

WITH the completion of a floating concrete dam across the Gila River in Arizona, (popularly called the Florence Diversion Dam), several remarkable accomplishments have been achieved, of interest not only to the engineer and the irrigation expert, but also to the general public at large.

The structure brings to an end a controversy over the waters of the Gila River, which has long disturbed the relations between the Pima Indians and the white farmers of this valley. A friendly agreement has been concluded under which the waters are divided on a basis of 35,000 acres of irrigated land for the Indians and 27,000 acres for the whites.

From an engineering standpoint, the structure is of more than passing interest. Porous foundation dams of the floating weir type, so common in India, have not been built in great numbers in this country, therefore a description of this project which was built as a diversion dam for an irrigation canal by the U. S. Indian Service, shows many unique features both in design and method of construction.

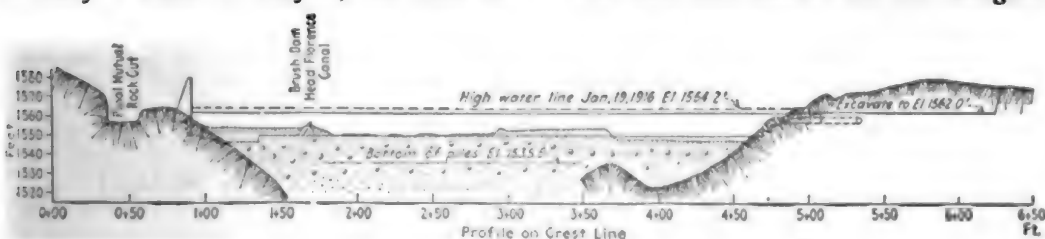
The dam is located about 12 miles above Florence at a point where the Gila River passes through a low granite ridge which is a part of the range cut by the lower Gila Canyon, the mouth of which is a few miles above the dam site. At the dam site the channel is about 400 feet in width with rock walls rising about 30 feet high on each side. Borings at this point disclosed the fact that the river bed is really a filled in canyon, the rock on

both sides of the river extending only a short distance into the channel and then dropping off vertically more than 100 feet. It being impracticable under these conditions to construct a dam on bedrock, the weir type of floating dam was selected.

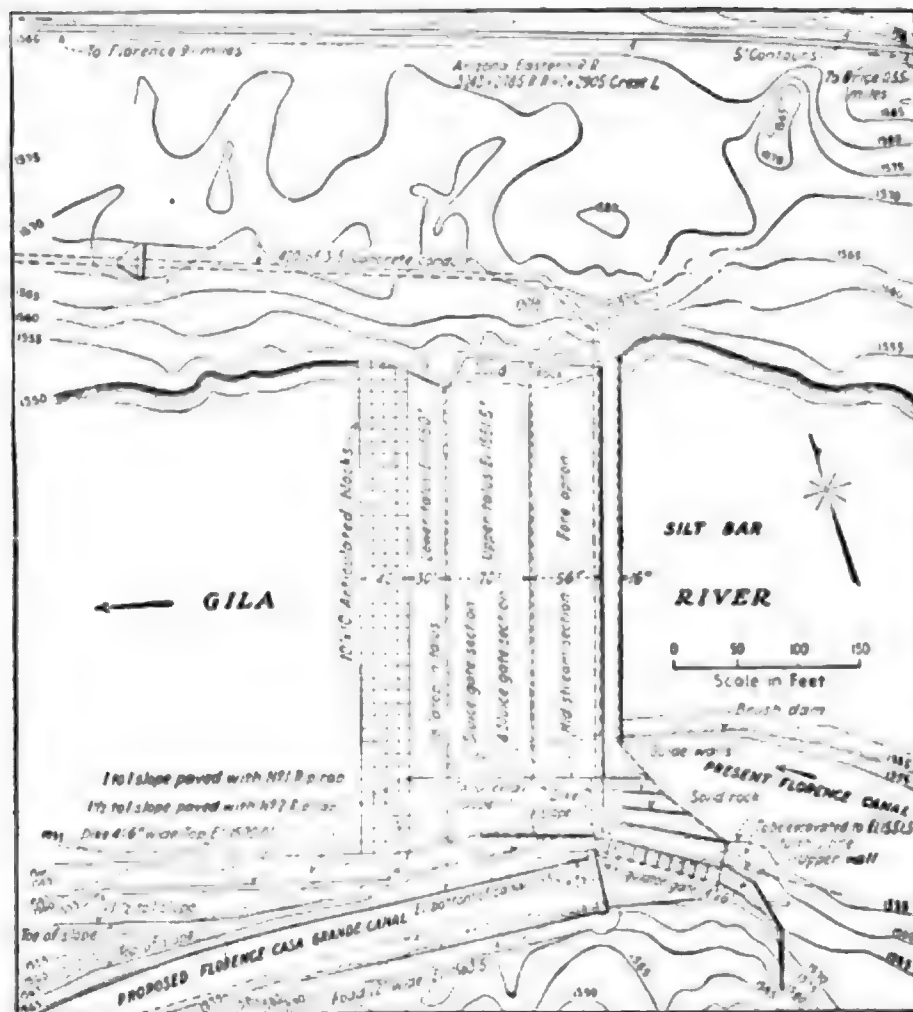
The Florence dam consists of a floating slab of concrete 396 feet in length, 212 feet in width and varying from 2 to 5 feet in thickness. It is keyed to the rock on both sides of the river and supports a hollow weir or dam, 10 feet in height of the same length as the slab. In order to provide greater spillway capacity the crest of the dam is extended into the rock forming the north bank, a distance of 120 feet. The total width of freeway for the passage of water from the wall of the intake gates on the south bank to the face of the upper rock cut on the north bank is 515 feet.

The weir is keyed into the face of the lower rock cut on the north, and on the south a retaining wall protecting the intake gates forms the abutment. A sluiceway provided with suitable guide walls is located in the weir immediately in front of the intake gates. The intake works include a bank of nine regulator gates which divert water into the intake of the Casa Grande Canal 40 feet wide on the bottom, 6 feet deep and with a capacity of 1000 second feet. Like the spillway on the north bank the upper section of the canal, including the forebay behind the intake works, is blasted out of the solid rock.

The dam and headworks are designed



CROSS-SECTION THROUGH FLORENCE DAM SITE SHOWING POROUS BOTTOM



PLAN OF THE FLOATING DAM ACROSS GILA RIVER

to pass a maximum flood of 150,000 second feet. With such a flood there will be a depth of 17 feet of water over the crest, the elevation of which is 1562 feet above sea level. This depth required that the curtain wall in front of the intake gates should be brought up to an elevation of 1580 to avoid drowning the canal during high water. Additional free-board is provided by a solid parapet wall over the gates, 3 feet in height. The dimensions and relative location of the component parts of the slab and dam are shown in the accompanying plan and section. The sluiceway is located immediately in front of the intake gates so the sand and silt can be sluiced out before entering the canal. Openings through the dam are provided with four 4x8-ft. gates of the rising type separated by reinforced-concrete piers 3 feet thick, while the sluicing channels leading to the gates are formed by thin reinforced-concrete walls of appropriate height, shape and direction to assist in sluicing action.

A bank of nine 4x8-foot regular gates

of the folding or leaf type is provided for the heading of the main canal so that water may be skimmed from the surface of the river to prevent rolling sand and silt entering the canal.

The Gila Valley is usually subject two rainy seasons a year, one occurring between November and March, which generally occasions a continuous flow in the river but seldom gives rise to a large flood; the other extending from July 1 to September 1 is due to violent local disturbances which often cause extreme high water.

The work required for the completion of the dam comprised 25,000 cubic yards of rock excavation, 82,570 cubic yards of earth excavation and 12,933 cubic yards of concrete.

The pile-driving and the pouring of the slab had to take place in the bed of the river, and had to be done at the time of least danger from flood, since the river channel at the dam site was too narrow to attempt any diversion or flood protection, even if the expense were permissible.

It was finally decided that the only system that at all promised to satisfy the requirements of speed, flexibility and cost, was a set of tramways supporting a narrow-gage track over which small concrete cars could be operated.

The dam was appropriately dedicated on May 10, 1922, in the presence of a large assemblage of Arizona citizens and many members of the Indian tribes of the valley. The exact costs are not yet available but are known not to have been excessive considering the speed required and the adverse conditions under which the work was done. Including the formwork on the crest the cost of the concrete composing the slab probably will not exceed an average of \$13 per yard. The dam itself was completed within the estimate of \$250,000, which is below the lowest figure set by any contractor.



Look for this Blue and Gold Armco Label on Washing Machines, Stoves, Ranges, Refrigerators, Enamel Table Tops, and other household and commercial utilities. It carries with it the assurance of the quality and solid worth of the sheet metal parts of articles that bear it.



Ingot Iron

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You would accept a certified check

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MIDDLETOWN, OHIO

for the Permanent Road

On the Dixie Highway



In California



In New Hampshire

Installed 1907



In Service Since 1909

ARMCO CULVERTS

The purity of the ARMCO Ingot Iron maintains the structure against corrosion and insures long life and serviceability

A black and white photograph of a tree-lined road. A vintage car is driving away from the viewer down the center of the road. The trees are large and leafy, creating a canopy over the road. The scene is peaceful and scenic.

The **HIGHWAY
MAGAZINE**

**June
1923**

**Prize Winning Essays
in the
"ROAD PAST YOUR DOOR"
Contest (See Page 3)**

**Write to the nearest manufacturers for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock The Dixie Culvert & Metal Co.	Nebraska, Wahoo Nebraska Culvert & Mfg. Co.
California, Los Angeles California Corrugated Culvert Co.	New Hampshire, Nashua North-East Metal Culvert Co.
California, West Berkeley California Corrugated Culvert Co.	New York, Albany North-East Metal Culvert Co.
Colorado, Denver The R. Hardesty Mfg. Co.	New York, Elmira Highway Products & Mfg. Co.
Florida, Jacksonville The Dixie Culvert & Metal Co.	North Dakota, Wahpeton Northwestern Sheet & Iron Works
Georgia, Atlanta The Dixie Culvert & Metal Co.	Ohio, Middletown The American Rolling Mill Co. The Ohio Corrugated Culvert Co.
Indiana, Crawfordsville The W. Q. O'Neill Co.	Oklahoma, Oklahoma City The Boardman Co.
Iowa, Des Moines Iowa Pure Iron Co.	Oregon, Portland Coast Culvert & Flume Co.
Iowa, Independence Independence Corr. Culvert Co.	South Dakota, Sioux Falls Sioux Falls Metal Culvert Co.
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Maryland, Baltimore (Munsey Bldg.) The Maryland Culvert & Metal Co.	Texas, El Paso Western Metal Mfg. Co.
Massachusetts, Palmer New England Metal Culvert Co.	Texas, Houston Western Metal Mfg. Co.
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No.



Two general views of sections of the Government Experiment Station at Arlington, Va., where tests are being carried on under the direction of Earl B. Smith, Chief Testing Engineer of the U. S. Bureau of Public Roads.

At the top is seen a section of the circular testing track. Below is shown the series of slabs used for the impact tests, described by Engineer Smith in an interesting article on page 7, entitled "Doctoring the Sick Highways."





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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Women Build New Road at National Capital

INSTEAD of buying silk dresses when long skirts came back into style to be ruined in crossing muddy streets, the women of Capitol Heights, a suburb of Washington, D. C., led by Mrs. Grace Stansbury, president of the Capitol Heights Civic League, donned overalls

recently and improved the streets and nearby roads.

Capitol Heights is located just across the District of Columbia boundary in Maryland. The state wouldn't give any aid for the muddy, rutted roads but the highway commission consented to lend a road scraper. The husbands contributed the overalls. Then the women gave a series of dinners, carnivals, dances, card parties and popularity contests. In this way they raised funds to buy a tractor and a quantity of road material. Armed with these things, such picks and shovels as they could beg or borrow they went out and, among other things, built a stretch of road one and one-half miles long to link the Mariboro and Annapolis highways. While women mayors, street commissioners, inspectors, contractors and owners of gravel pits have been engaged in highway work for some time this is the first instance on record of voluntary labor on the roads by a group of women.

"No single improvement has done more for the general good of the country than the development of our highway system."—President Harding.



Proper and adequate drainage is one of the essentials of good road construction. A 24-inch Armco ingot iron culvert on the National Old Trails road in northern Arizona.

Wanted! A Good Road Past My Door

By MARGARET CAMP

Junior, Farmington High School, Farmington, New Mexico

In the following article, which was awarded first prize, Miss Camp, 15 years old, tells of the actual condition of the road past her door. How its condition has forced her to give up her home life in order to get a high school education; how it handicaps the economic, social and religious development of her county, and what its improvement would mean to the citizens of San Juan County, New Mexico.

EDITOR'S NOTE: We wish to take this opportunity to congratulate the hundreds of high school students in the United States and Canada who entered "The Road Past Your Door" contest. From the interest which has been shown and the fine quality of material submitted in this contest, it is evident that the younger generation is keenly alive to the highway problems of America. We also wish to thank the judges for the painstaking care they exercised in judging the stories. So many very good articles were received that it was only with great difficulty that the judges arrived at a decision. The first and second prize winning stories are printed herewith. The third prize winning story, written by Charles K. Arey, South Portland, Me., will be published in the July issue of The Highway Magazine.

(FIRST PRIZE)

A NATION must keep continuously surpassing previous methods and inventions in order to advance and be highly civilized. If a nation is not progressive its people will soon fall into a rut and will cease to hold an important place in the affairs of the world.

Every person of intellect has a natural instinct to improve objects or conditions affecting him. This instinct should be cultivated in every direction.

At the present time roads seem to be exempt from this natural desire for improvement. We are allowing our roads to deteriorate until they are below the standard of the old Romans. For proof of this, recall that sections of the Appian Way have been excavated and found in excellent condition. The Appian Way was constructed 2,300 years ago and was 120 miles long. Still later we find that many of the roads now in continual use in Holland were built by Napoleon.

There are very few American roads that

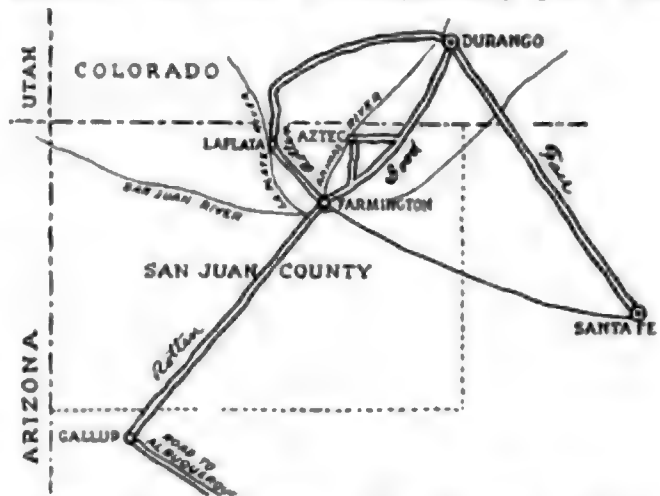
will last so well. Perhaps you may say that good roads are not necessary to civilization. Why then do engineers and contractors, with the aid of the federal and state governments, spend time and money in studying the construction of roads?

However, all roads are not up to the American standard. For instance, the road past my door is not.

This road is between Durango, Colorado, and Farmington, New Mexico. Since the Durango end is being improved I will only consider the part that is in New Mexico. It is in San Juan county and follows the La Plata River. The road connects the city of La Plata with Farmington, Durango, Gallup, Albuquerque and many small towns.

San Juan County has a population of about 8,500, of which 1,000 live in Farmington. Many new people are settling here, due to the oil boom. At present taxes are too high and the taxpayers resent a raise in taxes even for roads. Most of the agriculturists lost money the last two years because they could not get their products to market. The main occupations in San Juan County are farming, fruit growing, cattle raising, sheep raising, hay growing, coal mining and oil drilling. There are plenty of natural resources and people to develop them, but this is difficult until a railroad or highway is built to solve the problem of transportation.

There is a marked lack of interest and co-operation among the people concerning this road, which should be the best highway in New Mexico. The road is exceptionally poor and



Miss Camp's road map of San Juan County, New Mexico, showing the road past her door.

The Highway Magazine

should not bear the name. It has a bad effect on all the families in the La Plata Valley. For example, my family lives on the La Plata River, 15 miles from Farmington, where the nearest high school is located, and where my sister and I have to go to school. If the roads were good a consolidated school on the La Plata would be ideal, but as it is now, my sister and I, and many other children have to board in town, separated from home and its advantages. One must sacrifice home for education or vice versa.

School children are not the only ones inconvenienced by the lack of roads. Social gatherings are impossible. Church and Sunday school would be enjoyed, but they are not practical.

FARMERS CANNOT REACH MARKETS.

This year farmers on the La Plata raised good alfalfa hay worth \$15 to \$20 a ton in Farmington or in Durango, but it could not be hauled without too much trouble and expense. The result is that people near town sell their hay for \$20 a ton and La Plata hay rots in the stack. The same is true of fruits, vegetables and coal on a smaller scale. We need a good road more than some sections of the country, because there is no railroad in the La Plata Valley, and only a branch of the D. & R. G. extends to Farmington.

Many invalids, travelers and wealthy tourists visit this county on tours to the coast. Their pleasure is marred by the condition of the so-called highways. People, of course, cannot enjoy new and beautiful scenery when their Packards are stalled in a sand hole and there is little chance of getting out. Consequently, once people get out of the county they are not likely to return until aeroplanes are more popular or roads are constructed. Now is the time to start the roads, while the oil boom is at its height.

There is no reason why the roads should not be open and in good condition throughout the year, but they are not. June is the best month except for the dust.

About 10 cars and an equal number of wagons, also horseback riders and pedestrians, pass our house daily. If we had better roads the number would be doubled and tripled. The transportation of hay, coal, fruit and supplies to the oil wells must be done with wagons. Trucks would save two-thirds the time.

HIGHWAYS UNGRADED.

This road is not graded, many of the hills are so steep that a team and medium sized load cannot safely attempt to climb them. It is not level (from side to side) and is needlessly crooked. As an illustration; in several places the road goes 30 feet around a clump of sage brush that could be cut out in half an hour. The road is also covered with round slippery stones. At the top of nearly every steep hill is a very sharp turn, if two vehicles meet here one has to back a considerable distance to let the other pass.

Substantial bridges and culverts are unheard of things here. The bridges do not have firm enough foundations in the loose sand and when the rivers rise the bridges are washed out. If more money were spent on bridges when they

are first constructed, less would have to be spent for repairs and maintenance.

The culverts are for the greater part home-made, and while they appear strong, the traffic strain comes on them in the wrong place, and they don't last.

Irrigation is done on such a large scale that many culverts are necessary. When these culverts fail the road is flooded and the crops lose valuable water. It is not safe for an easily frightened team to cross the culverts, so they usually ford the ditch. Cars also use the ditches, for if a car goes about 20 miles per hour it only hits the worst bumps and culverts. After a little of this treatment the wooden culverts collapse.

The roadbed, supposed to be the foundation of the highway, is an imaginary thing here. Since there is a great variety of soils no single method of treating them can be followed. Sand is the most common soil and in summer causes far more skidding than mud ever does. (It only comes hub deep on a Ford.)

In other places blue and red clay abounds; also a soil similar to ashes, only harder. In wet weather the ruts are deep and it is hard to avoid breaking axles.

Fault can justly be found with the road signs and guide posts, a factor often slighted. Every one knows that a road in a farming district has many lanes and short cuts. It is easy for one not accustomed to the country to become confused. Signs are far more important than many people realize.

ROAD BUILDING MATERIALS ABUNDANT.

There is very little excuse for the bad condition of this road.

Good sand and gravel are found practically everywhere. Materials for brick are part of the natural resources of this section of the country. Sandstone is also abundant. The pine wood sawmill in Colorado is not far off.

Labor is comparatively cheap now because many men have come to witness and take part in the oil drill operations, and they are out of work and money. These men will work for enough to buy board and room and cigarettes.

This section of New Mexico has, I believe, all the elements necessary for highway construction at low cost, yet not even a policy of adequate maintenance nor spasmodic reconstruction is followed. What little work that is actually done is only a makeshift after the following manner.

Suppose a farmer is hauling a heavy load of hay in muddy weather and he finds a terrible rut that is impassable. There is not sufficient room to turn out or turn back and he has to pass. He will get down and cut several armfuls of sage-brush and lay them across the rut. Then he goes on and never gives it another thought. Perhaps some farmer will be more constructive. If he finds a gully across the road on each side of a culvert, making the road dangerous, he may donate time and haul a load of waste from the hog pen and spread it in the bad places. Frequently some enterprising citi-

zen will dump a load of ashes or cinders on the road.

Town men travel on the road when necessary and "cuss" everyone from the farmers to the President, except themselves. They won't realize that if they would give 50 cents or work an hour for every "cussing" they give the road, it would not need anything except compliments.

Should the work of road construction be left entirely to the contractors and road engineers? Or should we voluntarily, as a group of individuals, take our share of the work, expense and benefits of model highways, as the old Romans did?

If we can surpass our ancestors' methods and implements, we certainly should surpass them in the construction of our highways.



Currituck High School, North Carolina, of which Alton D. Taylor, winner of the second prize, is a student.

What Good Roads Have Done for the Schools and Citizens of Currituck County, N. C.

By ALTON D. TAYLOR
Freshman, Currituck High School

"I hereby certify that the local pictures taken by A. D. Taylor are true and exact illustrations of Currituck County, and his composition is not an exaggeration, but facts, pure and simple. Witness my hand and official seal, this 7th day of March, 1923."

Signed: J. A. Taylor, Registrar of Deeds.

(Second Prize)

THE road past my door is an excellent highway, but as this road has not always been good, I can more easily appreciate it as it now stands.

In 1917 the people of Crawford Township, Currituck County, North Carolina, realizing the importance of education, consolidated and built a High School at Currituck, our county seat. After this was done, there was still a three and a half-mile walk over a bad and muddy road for some of the pupils, and I was one of those living at a distance.

The school thrived, and with the whole-

hearted co-operation of the teachers, got practically one-fifth of the population of the county interested in our work, but our plays and entertainments were attended only with great difficulty by the people, because of the unimproved condition of the roads.

In 1918, the Board of County Commissioners, prompted by the great work in education that was going on at our High School, and by influential citizens who realized what a handicap the unimproved roads were, voted for an issue of \$80,000 in bonds, to drain, grade and properly culvert our roads. This was done with much success, as our sandy land has a sub-soil of a clay nature, and after the roads were plowed deep, graded and drained with culverts and ditches, we had beautiful and serviceable sand clay roads, which we could now never do without.

I live in what is geographically termed the coastal plain of the United States, and there are numerous swamps throughout the region. With a system of ditches and tile drainage to these bogs, we never have any water standing on the roads. (Right here let me say that drainage is the prime factor in building roads in this section.) The greatest problem developed where the road passed over these bogs. The way this problem was solved was by elevating the road with a mixture of sand-clay hauled from the near-by high land.

This work was done by an expert supervisor. He used two army trucks for hauling and plow-



The road past Alton Taylor's door.



Constructing a road in the Albemarle Sound region. The pipe clay excavated from the drainage canal makes the basis of the roadbed.

ing, a grading machine and a heavy road drag or leveler.

In 1921 when our State began road improvement, our county showed so much progress and improvement in road construction work that its highways were held up as an illustration of what good roads should be, to all state road officials. Recently a famous Italian statesman came to North Carolina for the purpose of studying road construction methods which he intends to use upon his return to Italy. The state is giving us about 65 miles of hard surfaced roads, leaving our County Highway Commission about 100 miles to care for.

Our county is a peninsula jutting into Albemarle Sound, and we have numerous islands connected with the mainland by marshes. In the future we will carry to completion the roads to these islands. One has just been completed at a cost of \$15,000 for 8 miles of roads. Expensive, it is true, but worth it, considering an island of 2,000 inhabitants with no thoroughfare to the city! Another such project is in progress at a cost of \$6,500 for three miles of road, shown in an accompanying photograph.

Mr. Joseph P. Knapp, New York multi-millionaire and world-wide sportsman, made a visit to our county in 1920, and became so im-



Future citizens of Currituck County on an elevated road over a marsh.

pressed with the thrift and versatility of our citizens and the great progress in our road and school work, that he purchased Mackey's Island for a winter home of his own, and gave his citizenship to Currituck County. The transition of this island to a beautiful park and country home, is a story in itself. This island is connected with the mainland by an improved road of pipe clay. Being thoroughly drained with proper culvert installations, it is always hard, making a perfect highway.

Mr. Knapp, after seeing what we had done to help ourselves in the way of good roads and schools, donated to our county \$100,000 for still further development of our schools and roads, and also to beautify our county seat, including the completion of a monument to our Confederate dead.

In conclusion, dear reader, whoever you may be, I wish to say Currituck citizens have worked hard for their school and road progress, but we have much to gain. Mr. Knapp referred to this, saying he was more willing to help those who were trying to help themselves.



Currituck County High School; \$5,000 is to be spent on additions, beautifying the grounds, and the completion of the monument to the Confederate dead.

Luke 19, 26th verse: "That unto every one which hath shall be given; and from him that hath not, even that which he hath, shall be taken away."

The High School boys and girls are our greatest factor in promoting school and road improvement. This is a strong statement, but I can prove it from observation and experience. That would be another story, however.

As I have stated before, due to the geographical situation of our county, we have to expend large sums of money on a few miles of road. Many counties do not have these difficulties, and I do not see that there is any need for their having mud roads any more. If the grandfathers of the people in these counties could arise from the tomb they would be greeted with everything new save the old rough, rugged, unimproved roadway past their doors. "Carolina, Carolina, heaven's blessing attend her,

While we live we will cherish, protect and defend her."

Doctoring the Sick Highways

By JOSEPH H. WALTON

Washington Correspondent for The Highway Magazine

The following article, including all data, methods, and description of instruments and devices used by the United States Bureau of Public Roads in the series of tests conducted at the Government Experiment Station at Arlington, Va., is based on an authentic interview with Chief Testing Engineer Earl B. Smith, in charge of the tests described below.

EVERY individual is dependent on the highway system of the country for the necessities of life. We are dependent alike on the super-highway with its smooth concrete surface and the little mud road that lies back in an obscure farming section. The truth of this statement is evident in that practically everything we use at some time passes over the highways.

When you buy a pair of shoes and they are delivered to your door, perhaps several miles removed from the store where they were purchased, they have made a trip over a part of the highway system. This final trip is only one of a probable 12 or 15 trips which that pair of shoes has had during the process of their construction.

Multiply this one product by many thousands and you will know in a small measure how dependent each one of us is upon the public roads. Take bread, milk, potatoes, hats, clothing, cotton, wool, your table and chairs, and follow

them from the raw material to the finished product and you will find that each of these articles of everyday use passes over the roads in the same way as the shoes, in a greater or lesser degree.

Therefore, our system of roads, aggregating over two million miles in length, is an essential part of our transportation system.

In 1921 highway improvement cost the people of this country \$600,000,000. Of this sum \$120,000,000 were paid by automobile license fees, leaving \$480,000,000 paid by State and Federal taxes, road bonds, etc. Apportioning this equally among the 105,000,000 inhabitants of the United States we learn that good roads cost every man, woman and child one and one-quarter ($1\frac{1}{4}$) cents per day. Knowing these facts we realize the importance of building roads that will withstand the heavy modern traffic.

The transition from horse-drawn to automobile and truck traffic has changed the surface and strength requirements of



Apparatus designed for measuring irregularities of pavement surface in the test of bituminous pavements.



The electrically-driven automobile device which constitutes the traffic in the concrete wear tests. Note that the drive is through one of the traffic wheels to simulate the action of the rear wheel of a truck.

the roads. Heavy truck traffic has developed very rapidly.

With the realization that this heavy and severe traffic is here to stay and will in all probability increase in weight and density, means are being sought for constructing such roads as will carry the added burden. In order to learn what materials are best suited for use in road building and what methods of construction are most durable, the United States Bureau of Public Roads is conducting a series of tests at its experiment station situated at Arlington, Va.

These tests are under the general supervision of Earl B. Smith, Testing Engineer, in charge of the Research Division. Many of the instruments and machines used in this particular line of investigation are designed by Mr. Smith and constructed under his personal direction.

Mr. Smith has had extensive experience in mechanical engineering and was for nine years assistant professor in charge of mechanical, hydraulic, and strength of materials engineering Laboratories at Drexel Institute in Philadelphia. He was also employed by the Philadelphia Rapid Transit Company as erecting and testing engineer for several years prior to his entry into the Government service in 1914.

In explaining the tests that are being conducted at this time Mr. Smith said, in part:

"It is known that there are four im-

portant factors to be considered in road design, namely: impact; pressure or weight of the passing load; horizontal shear and tractive forces; subgrade and soil conditions. Each of these factors is being thoroughly investigated. More progress has been made in the study of impact than any of the other factors, however.

"The term 'impact' in its ordinary use means the force with which a moving body strikes another body. The term is used here in this sense, and its specific application is to the force resulting when a truck wheel strikes the surface of a road. This action may occur when the wheel, traveling over the road surface, falls from one level to another, or when it strikes an obstruction and bounds upward and finally falls to the road surface.

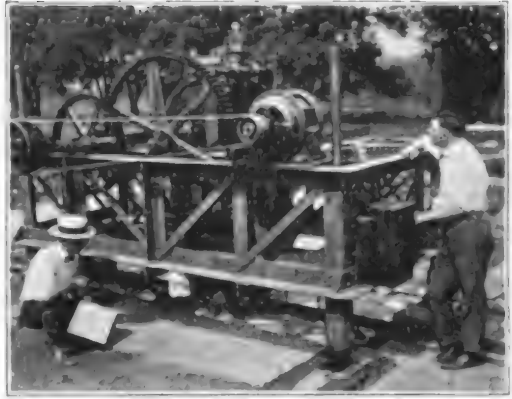
"To determine the effect of these impact forces on roads of different types and of different supporting strengths, we have designed a portable impact machine which, in action, simulates that of a motor truck. It consists essentially of a motor truck wheel which is carried on a heavy truck spring. This constitutes the unsprung weight and it is operated in a vertical motion by means of cams carried on the outside supporting angle-iron frame. The height of drop of the truck wheel may be regulated from 0 to about 6 inches, and from 6 to 10 drops per minute may be obtained. The value of the spring pressure may be varied, and also the total value of the unsprung weight may be changed by the addition of suitable weights. Impacts may be obtained varying in value from 0 to that of a ten-ton truck.

"There has been constructed at Arlington a series of 120 slabs seven feet square and representing the different types of road construction, including plain concrete slabs varying in thickness from two to eight inches, and brick pavement construction on concrete bases of different thicknesses. The test is made by mounting the impact machine over the particular test-slab to which the impact forces are to be applied and allowing the unsprung weight to fall a height of one-eighth of an inch 500 times, then raising it three-eighths of an inch more, and allowing the unsprung weight to fall a height of one-half inch for another 500 blows, and so on, increasing the height

of the fall three-eighths of an inch each time until failure occurs. The slabs are hammered in this way in the center, on the corners, and on the sides so as to obtain the relative strength under these different conditions. Careful measurements of the settlement of the slab are taken after each 250 blows. This permits the drawing of a curve showing the settlement of the slab due to the different impact forces applied.

"Another experiment which has attracted a great deal of attention," continued Mr. Smith, "is one which determines the extent of vertical movements of concrete slabs. The edges of these slabs have been found to curl up and down, depending upon the relative temperatures of the upper and lower surfaces. When the top surface is warmed the edges move downward; when the top surface cools the movement is in the opposite direction. We find that the motion is so responsive to the warmth of the sun that it is possible to detect almost instantly the effect of a passing cloud. The extreme movement observed thus far is about two-tenths of an inch."

The Bureau of Public Roads, as well as private engineering enterprises, has long felt the need of some means of determining the actual force of impact in pounds. When the truck wheel pounds down on the slab it simulates the action of a truck traveling over a road when it passes over such surface irregularities as waves, pot holes and joints. It has been impossible heretofore to determine with any reasonable degree of accuracy the actual force of this impact in pounds.



Engineer Smith checking up the results of the impact test. This portable road impact machine was designed by Mr. Smith.

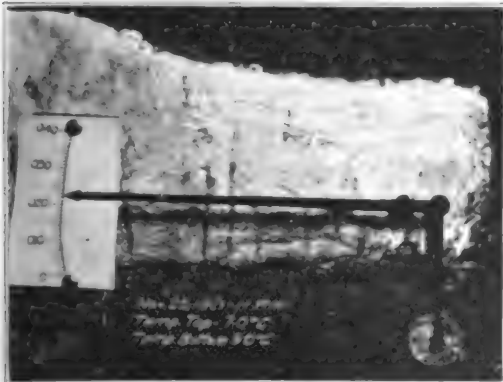
Mr. Smith has designed a delicate instrument which is used for this purpose, called the decelerometer. It can be fitted to a truck wheel, a pile driving hammer or any place where it is desired to determine the actual force of impact.

"This little instrument is a great help to us in our experimental work," declares Mr. Smith. "We can determine, with the aid of the decelerometer, whether the blow delivered is ten pounds or ten thousand pounds, with an error of less than five per cent.

"A study of the cause of wavy road surfaces is also being made. For this we have constructed a circular track 15 feet wide and 180 feet in diameter. The circumference of the circle is divided into sections, each of which is surfaced differently with various kinds of tar and asphalt pavement, some of them on concrete bases. The 'traffic' to which these sections are being subjected is supplied by an electrically driven device.

"In line with the Bureau's policy of cheapening the cost of road construction by use of local material wherever possible, a circular track for wear tests on concrete has been laid alongside the track just mentioned. Sixty-one sections of concrete have been placed.

"Results of this wear test, representing modern traffic conditions, together with the beam strength and compression tests which have been made for this investigation, will furnish a sound basis for the consideration of suggested changes in specifications for concrete road aggregates."



An instrument for indicating and measuring the warping of road slabs due to temperature changes.

Constructing an Earth Fill With Drainage Water

By SAM G. LOUCKS

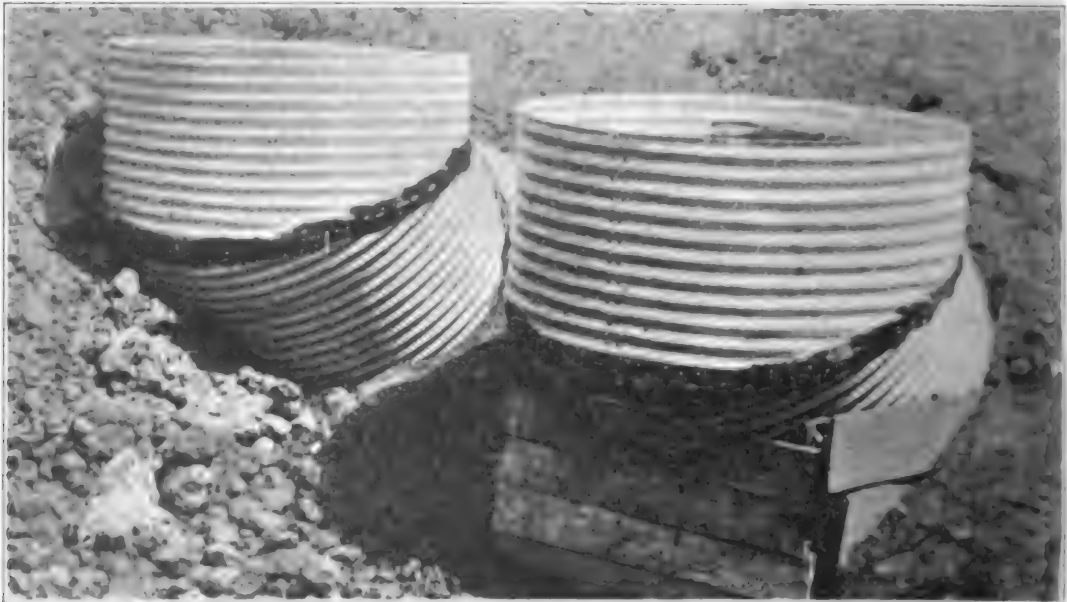
County Engineer, Holt County, Missouri



Twin Armco culverts 42 feet long and 60 inches in diameter, used in the installation described in the accompanying article, before the elbows were attached.

THE accompanying photographs illustrate a method used with success in Holt County, Missouri, to prevent soil erosion from run-off water. The installation consists of twin Armco culverts, 42 feet long and 60 inches in diameter, equipped with right angle elbows. The elbows were placed on the upper side of the fill with the openings upward. Surface drainage water, impregnated with soil from the adjacent farms, flows down against the fill and must rise to the level of the elbow openings before it can flow into the culverts. This process allows the suspended soil to settle around the outside of the elbows instead of being carried away through the culverts.

In a short time the fill is gradually built up to the top of the elbows. A two-foot section of Armco pipe is then added to the elbow and the process continues until the fill is as high as desired. This type of installation makes a very valuable soil saver which is both practical and economical.



The finished installation described above. Soil-impregnated water must rise to the tops of the elbows before being carried away.

Charting the Lost Roads of Death Valley

The dangers of crossing Death Valley and the Panamint Desert in a motor car today are nearly as great as in the days of '49.



At the entrance to Emigrant Pass in the Death Valley region. Note the large sand crater at the left.

IN an effort to open for motor travel the hitherto uncharted sections of the California desert regions, an exploring party of California motor enthusiasts recently completed a trip through the menacing but picturesque sections of Death Valley and the Panamint Desert.

The objective of the search was the final resting place of the "Lost Mormons" who died in a futile endeavor to reach the coast in '49. It is planned to establish a route into the desert to be known as the "Lost Wagon" trail.

Somewhere, far to the north of Death Valley, lie the lost wagons of the Mormons, still undiscovered, and guarded only by the bleached bones of the mules that dragged them across the burning sands.

Romance, Adventure, and possible Death, await the unwary traveler of today through these regions, just as it did in the pioneer days when a stage coach route ran through Emigrant Pass. The last vestige of this old road that marked the trail of the stage coach has long since been obliterated by the sand and rain storms that sweep down from the Panamint Range of the Black Mountains.

A brief account of the physical difficulties encountered by the charting party

and the topography of the country is of interest to road builders, in that it brings out the obstacles engineers are encountering in building highways through regions visited by sand storms as in the Imperial Valley, California, where much the same conditions exist with the exception that the Imperial Valley is inhabited and water is abundant, while in the Panamint Desert and Death Valley the country is a trackless waste with few and uncertain water holes.

O. W. Lewis, a member of the charting party, describes Death Valley as a "replica of Dante's Inferno minus the spirits of the damned." And yet there is a strange lure about this land of mystery. Mr. Lewis continues:

"Many days were passed in the Valley and in the adjoining country without seeing a living human face. There is something about this country quite unlike any other, and it has a wierd fascination to anyone who has ever entered it. Repellant as it is in many respects, there is an almost irresistible urge to see it again after having once entered its confines and camped within its borders.

"The little town of Ballarat is the last outpost of civilization before striking into the desert. Even here the tourist cannot



The little town of Ballarat, the last outpost before entering Death Valley.

always be sure of being supplied with water.

"From Ballarat to the floor of Death Valley, many feet below sea level, via Wildrose Canyon and Emigrant Pass, is 58 miles. To attempt to drive this route is to invite disaster, as the entire road-bed has been completely demolished by the floods and storms. There are not even tracks which one can follow from the summit of the Pass down to the floor of the Valley and it was possible to make the trip only by picking out the line of least resistance.

"There was always the danger of getting lost, but with the aid of a government topographic map and with our previous knowledge of the country, we managed to get through safely but not without great difficulty.

"For a distance of 20 miles we had to drive through and cross many washes hundreds of feet wide and much of the distance it was necessary to move large rocks to make a path for the car.

"We finally reached the floor of the Valley and by chance discovered an old signboard pointing directly east, marked: 'Stove Pipe Wells—5 miles.' Another sign indicated that Salt Creek Wells lay 8 miles to the southeast. At this point the route lay through a range of sand hills and dunes.

"The trail became absolutely impassable a little more than a mile from Stove Pipe Wells, a large sand crater or pocket formed by recent sand storms finally blocked the path and we were forced to turn back. By letting the air out of our tires and working every inch of the way with shovels and canvas strips we finally fought our way back to the signboard again.

"Every sign of the road southeast to Salt Creek Wells had disappeared, but

we struck out across the sand dunes and after two hours of arduous work through deep ditches, cross-washes and heavy sand, we reached the Wells and made camp.

"Salt Creek Wells gets its name from a small stream of salt water bubbling out of the sand which forms a heavy marsh. There is no bridge across this creek and a day was spent in filling mud holes with brush and sand before we got the car across.

"The so-called 'road' from Salt Creek Wells to Furnace Creek—a distance of 18 miles—is impassable on account of heavy sand drifts. East from Salt Creek, and slightly north up the slope of the Funeral Range, there are a few tracks made by cars which previously crossed the Valley at that point. Following these isolated tracks for a distance of four or five miles we made the entrance to Boundary Canyon. Here the tracks merge and form an excellent road up Boundary Canyon and over the Funeral Range to the 'ghost city' of Rhyolite."

The accompanying photographs give but a faint idea of the desolate nature of the region and the difficulties of travel.

Extra equipment of every description was carried in order to repair the car in case of a breakdown. With the car out of commission, the least discomfort would be a hard walk of from 30 to 50 miles for food and water, with always the danger of getting lost lurking in the background.

The fact remains that while fascinating to a tremendous degree, an auto trip into and through Death Valley should not be attempted with less than two cars, ample supplies of extra food and water, extra supplies of accessories of every kind necessary, and the presence in the party of a thoroughly skilled mechanic.

Irrigation and Drainage

Metal Flume Shows Fine Maintenance Record on Merced Irrigation Project

ACTUAL service under field conditions is the basis upon which competent irrigation engineers select the type of flume which will carry water on projects, where the prompt and accurate distribution of water under all conditions means the saving of a year's crop.

The accompanying photographs are of three different installations of Armco flume at different points in the Merced Irrigation District.



A section of 700 feet of Armco flume installed in Dutch Colony, Merced Irrigation District, in May, 1922.



Six-year-old Armco flume at Cressy, California, in perfect condition.

Photograph No. 1 shows the Ward Canal Flume at Cressy, California, which was installed in 1917. Recent inspection

showed this flume to be in excellent condition. There was not the slightest indication of rust and the engineers on the project stated that it had never leaked a drop.

On the basis of this fine maintenance record, 700 feet of Armco flume were installed five years later in Dutch Colony, Merced Irrigation District as shown in photo No. 2. Following installation this flume settled 1 degree in the center for a distance of 200 feet. It was jacked back into place and has not leaked since. The hangar rods and compression members were not touched in the jacking process.

Photo No. 3 shows a section of the La Grande Canal in the same irrigation district installed in January, 1923.



La Grande Canal, Merced Irrigation District; 416 feet of Armco flume installed in 1923.

Hydraulic Tests of Calco Automatic Drainage Gates

By PROF. FLOYD A. NAGLER

Associate Professor of Mechanics and Hydraulics
In Charge of the Hydraulic Laboratory, State University of Iowa

[Reprinted from The Transit, State University of Iowa,
Volume 27, February, 1923]

DURING the month of November, 1922, the Hydraulic Laboratory of the State University of Iowa conducted a series of tests to determine the amount of head lost by water discharging through "Calco" automatic drainage gates.

The "Calco" gate is made in sizes from 8 to 84 inches in diameter, and is the simple double-hinged iron flap valve made for use on the downstream end of outlets which are subject to backwater. The double hinge is so flexible in its operation that there is but very little obstruction to the flow of water when the pipe to which it is attached is flowing full; and the cast iron shutter and valve seat are accurately machined to insure water tightness when forced against the seat by water pressure from the outside.

The Calco gate has had a wide field of application, in the drainage of low lying and flat lands. Such lands often lie adjacent to and comprise only a small part

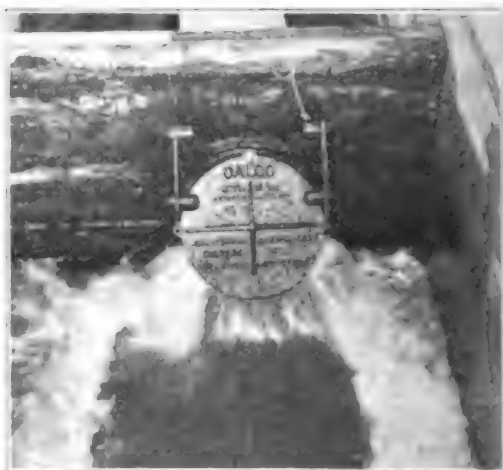


Fig. 2. Thirty-inch Calco gate with water discharging freely into air at the rate of 29.8 cubic feet per second.



Fig. 1. Looking down upon the testing section between the two bulkheads. See page 15.

of the total area tributary to a large stream, and may be submerged under water for long periods of time due to high water conditions in the stream itself rather than due to the amount of precipitation received on the low lying side of the tributary thereto. These adverse conditions are met by building suitable dykes or levees between the low lying fields and the water courses. Outlets through the dykes are provided to take care of the drainage from the fields themselves, and flap gates, of the Calco gate type are installed at the down-stream end of these outlets. As long as the field stands higher than the water in the stream it continues to drain off, but when the stream rises from other causes the inflow from the stream to the low lying area is automatically cut off by the swinging of the gate against its seat, where even a small pressure from the stream side will hold it firm. Gates of this type are employed under similar conditions on outlets from tidal marshes and irrigation canals. They are also installed at the outlet of

drainage lines to prevent small animals from entering and filling the pipe with rubbish, clogging and making it useless.

Although manufacturers claim that the installation of one of these gates had practically no effect upon the capacity of the outlet, engineers have desired to have this fact proven or disproven by actual experiments.

The gates were tested in the canal of the hydraulic laboratory. Each gate was attached to a ten or twelve foot length of Armco Corrugated iron pipe of the same diameter as the gate. The pipe was installed in the flume by building a water tight bulkhead at the upstream end and constructing a second water tight bulkhead a few inches upstream from the downstream end of the pipe to which the gate was attached. All of the water passing down the canal was thus forced to pass through the pipe and the gate. The quantity of water was measured by means of a five foot sharp crested weir located in the canal twenty-five feet upstream from the pipe. The quantity of water passing through the gate was regulated entirely by the head gate at the upstream end of the canal. In order to test the gates when operating both submerged and freely in the air, a bear trap weir was installed across the canal about fifty feet downstream from the

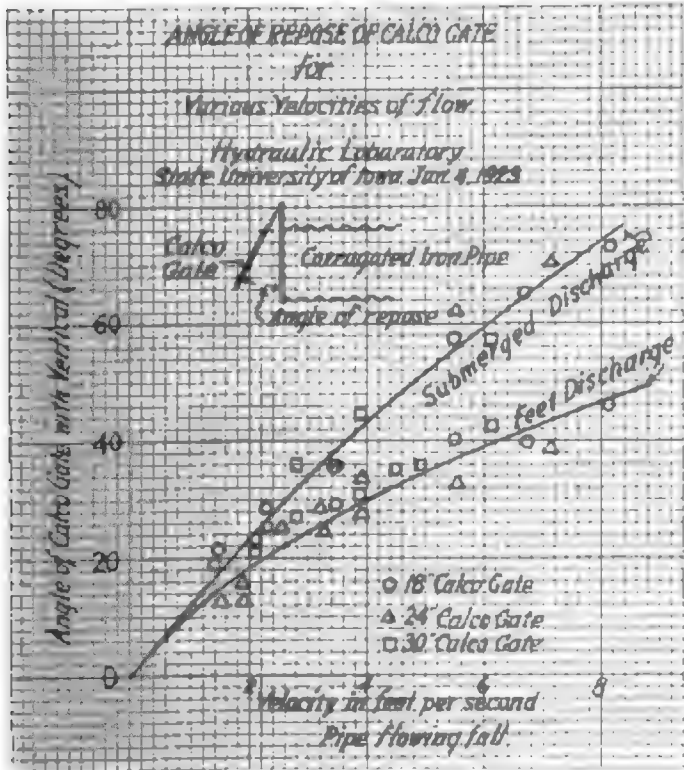


Fig. 3. Graph showing angle of repose of Calco gate for various velocities of flow.

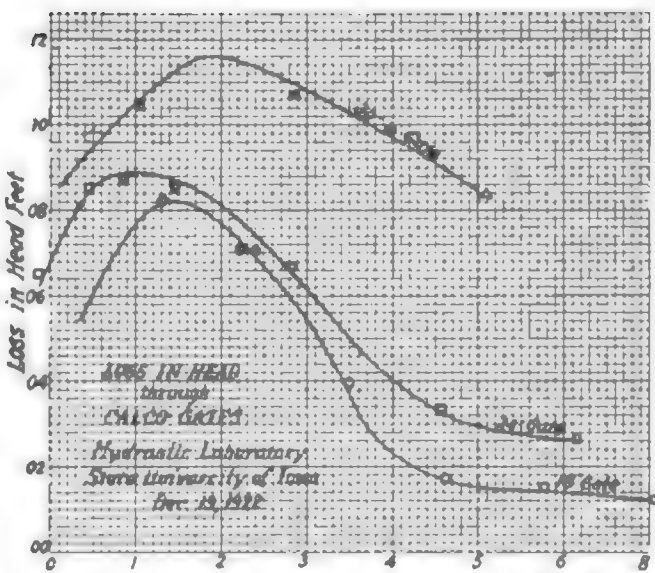


Fig. 4. The different curves in the above graph show the amount of head loss for different velocities of flow for each of the three gates tested.

gate, by regulation of which any desired water surface elevation could be obtained. The space between the two bulkheads was utilized by the observers. Along the wall of the canal there was installed piezometers connecting to the pipe and the hook gauges by means of which the water levels, upstream and downstream from the bulkheads were measured. The photograph in Figure 1 was taken looking down upon the testing section just described. The bulkhead at the downstream end of the pipe is in the foreground. The observers are engaged in reading the piezometers and hook gauges.

The loss in head caused by the Calco gate was measured by making two tests with identical quantities of water flow through the gate; in the first test the shutter of the gate was raised clear of the water so as to make it ineffective and in the second test the shutter was released so that the gate acted as it normally would. If the pipe was flowing full, any difference in piezometer readings or in the level of water surface upstream from the entrance to the pipe or in the total amount of head lost by the water as it passed through the pipe and gate, indicated the amount of head loss caused by the gate. In this manner each gate was tested with the water at the outlet end discharging freely into the air and with the outlet entirely submerged, maintaining a uniform discharge through the apparatus for all four experiments. Other experiments were then performed with different quantities of water flowing

through the gate in order to obtain about twenty-five experiments on each gate with velocities of flow covering a range of from one to eight feet per second.

Figure 2 shows a picture taken of the 30-inch Calco gate when water was discharging freely into air at the rate of 29.8 cubic feet per second. The cast-iron shutter can be seen riding freely on the issuing jet hardly obstructing the flow of water at all, with a loss in head caused by this gate of less than .01 feet diameter.

The loss in head caused by a Calco gate is obviously dependent upon the amount of obstruction caused by the shutter, and the amount of obstruction caused by the shutter varies with the angle at which it hangs.

The angle at which the shutter reposes is shown in the diagram of Figure 3. Thus with a velocity of 6 feet per second the shutter rests at an angle of 39 degrees with the vertical if the jet is discharging freely into the air; whereas the angle is 60 degrees if the gate is submerged.

The final results of the experiments are shown in the diagram in Figure 4. The curves on the diagram show the amount of head loss for different velocities of flow for each of the three gates tested, and are based on a submerged condition of outlet only. In no experiment was the measured loss greater than .01 ft. with the outlet exposed to the air. It is apparent from the diagram that the loss in head increases with the size of the gate and is a maximum for velocities of flow between two and three feet per second, when the gate is reposing at angles between 23 and 34 degrees.

Based on these experiments the following empirical formula was derived to express the loss in head through Calco gates of varying size and with different velocities of flow:

$$L = \frac{4v^2}{g} \times e^{-\frac{1.15v}{\sqrt{d}}}$$

L =loss of head in feet

v =velocity of flow through gate in feet per second

d =diameter of outlet in feet

e =base of natural logarithms

$\frac{v^2}{2g}$ =velocity head of water in outlet

Without further experimentation the accuracy of this formula for gates of other

sizes than those experimented upon is somewhat questionable; however, it is interesting to note that by this formula the maximum loss in head for a gate as large as 72 inches in diameter is .30 ft. when the velocity through the outlet is four feet per second.

Tests were made on the 30-inch Calco gate to determine how effectively the gate acts when backwater forces it against its seat. The photograph in Figure 5 shows a section of 30-inch Armco corrugated iron pipe to which a Calco gate had been attached at the far end. This gate cannot be seen in the picture because it is under the body of water, in the background, which is so deep that some of the water can be seen discharging over the bulkhead which confines it. In spite of the head of backwater to which this gate is subjected the amount of water which is leaking through the gate and trickling from the pipe is only .0015 cubic feet per second.

It may be concluded from these experiments that the Calco gate in its hydraulic characteristics is all that the manufacturers have claimed for it. The small loss in head obtained through these gates demonstrates that their installation has but little effect on the discharging capacity of drainage outlets; and that they may be depended upon to effectively stop the inflow of backwater.

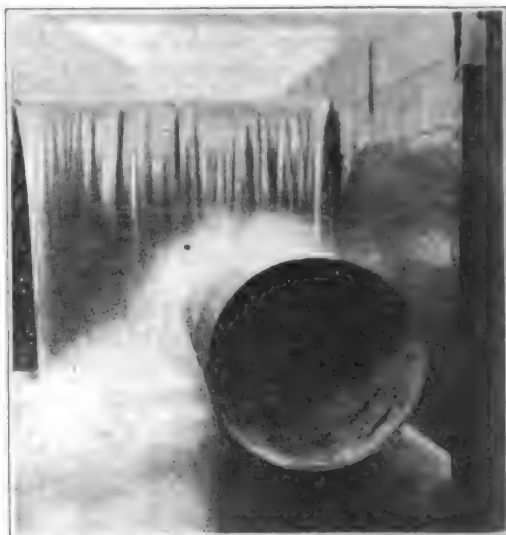


Fig. 5. A 30-inch Armco corrugated iron pipe with Calco gate attached to submerged end during the backwater flow test.



When Iron Runs Like Melted Butter

A gaping crack or a break in the iron! Five to six thousand degrees of heat blazed into the crack until the iron melts! Then the welding metal flows into the open space, makes a perfect union with the broken iron, and the break is healed.

Welding is not like sticking together two pieces of wood with glue. In welding, the iron that is used to fill the crack must become an inseparable part of the iron that is broken (or of the two parts that are to be joined.)

"Armco" Ingot Iron makes a perfect union. Impurities that might prevent this have been removed from "Armco" Ingot Iron, permitting the tiny molecules to hug one another closely.

The same basic purity which makes "Armco" Ingot Iron perfect for welding, insures resistance to rust.

Culverts made of "Armco" Ingot Iron are guaranteed 99.84 per cent pure, and will resist corrosion under the most adverse conditions.

Thousands of "Armco" culverts, corrugated to add strength, and covered with a two ounce coating of galvanizing per square foot of metal to give even greater resistance to corrosion, are in perfect condition today after a decade of service.



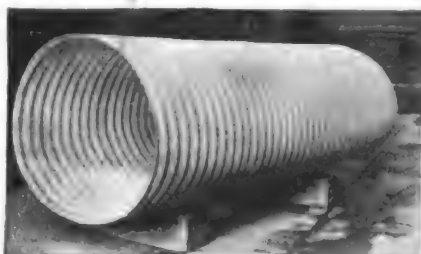
Write for Needed Information

The American Rolling Mill Company

MIDDLETOWN, OHIO

Your Two Questions About CULVERTS

Are they strong? | Will they last?



Proved Practically Uncrushable by Laboratory Tests

This stock Armco Culvert, 8 feet long and 36 inches in diameter, tested by Prof. Talbot of the University of Illinois, carried a load of 92 tons (11½ tons per foot) without fracture or loosening of the joints.



Used Under Tons of Earth In Deep Fills

Armco Culverts are in frequent use under fills as great as 80 feet. The corrugated construction, ample gauge, and patented method of jointing give them the strength to carry these enormous loads.



Armco Ingot Iron Steel



Rust-Resisting Because Made of PURE IRON

Iron to be rust-resistant must be pure in analysis, and smooth in section—free from gases. The diagram shows how Armco Ingot Iron compares in section and composition with ordinary steel.



The First ARMCO Culverts (1909) Are In Perfect Condition

This culvert, installed thirteen years ago under the tracks of a prominent transcontinental railway, shows no sign of deterioration today.

ARMCO CULVERTS



Ingot Iron

25.705
47
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The HIGHWAY MAGAZINE

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**Cutting the
Auto Death Toll
in Wisconsin**
See Page 5

**July
1923**

**Write to the nearest manufacturers for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equip. Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Calgary, Vancouver, Vernon

The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIV.

JULY, 1923

No. 6

"The Road Past Her Door"

Miss Margaret
Camp (below),
winner of the first
prize in the High-
way Magazine
Essay contest
"The Road Past
Your Door."



THE accompanying illustration of roads in the La Plata Valley, San Juan County, New Mexico, shows the need for better highways in this section, which Miss Camp discussed so ably in her prize-winning essay, entitled "Wanted! A Good Road Past My Door," which was published in the June issue of *The Highway Magazine*.

Miss Camp, whose picture appears above, is 15 years old and is a member of the junior class in the Farmington High School, Farmington, New Mexico.

These are the roads, leading to and from her home, which make it necessary for her to live away from home in order to attend high school.



JULY, 1923

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Armco Culvert & Flume Manufacturers'
Association

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ARNO B. REINCKE.....Editorial Director
CHAS. B. CORY, Jr.....Managing Editor
FRANK E. KENNEDY.....Associate Editor
LOUIS A. GRAHAM, M.E.....Consulting Editor

Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

These Students Received Honorable Mention In "The Road Past Your Door Contest."

THE first and second prize winning stories in "The Road Past Your Door" Contest were published in last month's issue of *The Highway Magazine*. The third prize winning story appears in the present issue.

The names of the high school students receiving honorable mention in the contest are published below:

Name	Address
Willard Johnson.....	Redfield, Iowa
Nelle N. Ober.....	Redfield, Iowa
Charlotte Payne.....	1802 Myrtle Street Sioux City, Iowa
Rex D. Hays....	McCool Junction, Nebr.
Edna Bunstock.....	McCook, Nebr.
Adelina Challburg.....	Sutton, Nebr.
Marguerite Young .....	.....
.....	District 75, Scranton, Kans.
Velma Munger.....	Plains, Kans.
Donald A. Grant.....	.....
.....	524 W. Ganson St., Jackson, Mich.
Ethel Robinson.....	Zeeland, Mich.
Lola E. Dew.....	Elkton, Mich.
Stewart S. Kissinger.....	Ashton, Mich.
Peter J. Boylan.....	.....
.....	R. F. D. No. 4, Portage, Wis.
Charles Smith .....	.....
..	R. F. D. No. 1, Box 52, Glencoe, Pa.

Name	Address
Ethel M. Walls.....	Baltimore, Md.
Mary F. Logan.....	.....
.....	Rising Sun, Cecil County, Md.
A. Rebecca Logan.....	Rising Sun, Md.
Emma Lockard .....	.....
.....	Route No. 3, Northeast, Md.
Elvin Bowen .....	.....
.....	Port Republic, Prince Frederickstown, Md.
Walter Gott.....	Calvert County, Md.
Lorene Nelson.....	Linden, Texas
Ven Carroll .....	.....
.....	Route No. 1, Gatesville, Texas
Mary D. Rose.....	Edina, Mo.
Gladys Hornbuckle.....	Clearmont, Mo.
Theora Devlin.....	Edina, Mo.
Hubert Street.....	Wheatland, Mo.
Iris Garber.....	Lockwood, Mo.
Sybil D. Stearns.....	Hinsdale, N. H.
T. Carlton Pearson.....	Madison, N. H.
Florence W. Pearson....	Madison, N. H.
Ruth A. Pearson.....	Madison, N. H.
Mildred R. Nason.....	Madison, N. H.
Roland Lyman.....	Madison, N. H.
Martha Kennett.....	Madison, N. H.

Continued

1923 Highway Activity to Exceed Previous Years, Says Roads Bureau

HIGHWAY construction will proceed during the coming season on a much more extensive scale than ever before, in the opinion of officials at the Bureau of Public Roads. Not only is the amount of Federal aid money available 30 per cent greater than the amount available last year, but there are large balances from previous years which will be put under contract from this time forward. A portion of that amount is lost if it was not put under contract before July 1. Since it is improbable that any state will allow any of its Federal aid money to revert to the Treasury, it is expected that an unusual amount of work will be put under contract particularly in the southern states.

If Florida catches up with the road-building program, it will have to put 900 per cent more road work under contract than was placed under contract last year.

High School Boys Help Build Hard Surfaced Highway

By CHARLES KENNETH AREY

Freshman, South Portland High School, C. B. Haskell, Principal

Public spirited citizens and unique construction methods solve the problem of turning a mudhole into a well drained paved highway at low cost.

(THIRD PRIZE)

THE CITY of South Portland, Maine, is made up of what was once a number of loosely connected villages. These villages have now reached the dignity of city wards. The road past my door is in Ward One, and as this ward has a beautiful little bathing beach and a large summer colony, and as this road also connects two important Army posts it will be readily seen that the travel is heavy and varied all the year round.

Because of this heavy traffic the road had gone from bad to worse until for much of its length it had become in dry weather rough and dusty, and in wet weather an almost impassable mire hole, a nuisance to permanent residents, and a serious drawback to the summer business. As the city has a large territory and a small population it is hard to raise money for roads and other public work, but three years ago this road had reached a condition where the Commissioner of Public Works, Mr. H. M. Arey, determined that something must be done.

Now this little story will describe no difficult engineering feat and no unique methods, but will simply tell how one road was changed from mud to macadam at little expense by taking advantage of what nature had provided and placed ready at hand.

A public-spirited citizen was found who would give the city a long strip of stone wall as well as other excellent road material. The portable stone crusher was moved to the location of this wall, and a small crew, composed largely of high school boys, was put at work. The road was graded with a road machine which placed the worn-out road material in windrows, when it was easily loaded into carts and removed.

The crushed stone was placed in two layers to a total depth of eight inches. Each layer was rolled with a ten-ton steam roller, after which one inch of fine material was spread over the top and rolled. The road was given a crown of six inches. Two coats of Tarvia B. were applied later with a pressure tank. Drainage was taken care of through the Catch Basins, and all driveways requiring culverts were formed of eight-inch Armco pipes, fourteen feet in length.

Last year one coat of Tarvia B. was applied



C. K. Arey

and any pot holes that had developed were filled with Tarvia K. P. The road, after three years of use by all kinds of traffic, including heavy army trucks, is in as good condition, and cannot be told from expensive construction.

In the western end of this city there is a particularly bad stretch of loose sandy road which it is hoped to rebuild in the same way. This road will require more drainage culverts, most of which are already in place. In one particularly bad stretch there was an old brick arch which carried the water of a brook under the road and into the Boston and Maine R. R. drainage system. About a year ago this arch collapsed and was replaced by a modern Armco corrugated iron pipe, so that the road by somebody else's door is almost ready for the same simple, inexpensive, and entirely satisfactory treatment.

Good road gravel from any convenient pit, placed eight inches deep; well drained with Armco culverts and held in place with Tarvia B. would answer nearly as well as crushed rock, and the only reason a high school boy can see for not using this simple method is that it IS simple.



Perfect drainage is an essential factor in the construction and maintenance of good highways. An Armco culvert installed under a Federal Aid road.

An Improved Wooden Guard Rail Design

By FRANK S. PECK

Highway Engineer, Lawrence County, South Dakota

WOODEN guard rails employed on many State and Federal Aid roads are constructed in such a flimsy manner that all they amount to is simply a guide and have little or no value as a protection for fast moving vehicles.

On any of the well-traveled highways one can see a great number of places where cars and trucks have knocked out one and sometimes two or three panels of



(Above) Photo shows how 8-inch hub guard plank prevents cars from going through guard rail. (Below) Diagram of guard rail described in the accompanying article.

the generally-used light guard rails, breaking off the posts and shattering the planks so that the sections must be replaced.

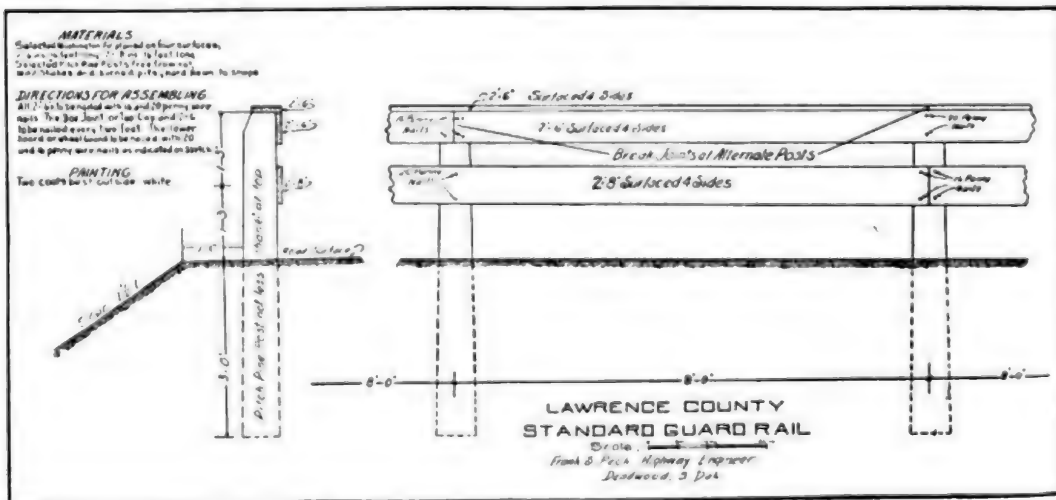
The design for guard rail which accompanies this article while not entirely new, has some features of safety that appeal to the traveling public. The rigid construction outlined gives a feeling of security.

This type of guard rail has been in use in Lawrence County for more than two years and has proved to be fool proof, as hundreds of autos and trucks have hit the fence and left their scars on the 8-inch hub guard plank without going through the fence. It is true that a plank and sometimes a post is broken but not a car or truck gets through.

By glancing at the accompanying plan you will see that the 8-inch plank is so located that it will protect the hub from hitting the post, and the car will slide along the fence without much damage.

Lawrence County is situated in one of the national forests and we are blessed with a bountiful supply of pitch pine which we use for the posts. These posts are nearly solid rosin and last for 25 or 30 years. Oregon or Washington fir is used for the boards which are carefully selected and are clear and free from knots.

This guard rail costs us from 40 to 50 cents per lineal foot erected, and covered with two coats of the best paint.





Accidents like the one pictured above happen more frequently on straight roads than at any other point, according to the data contained in the following article.

Cutting the Auto Death Toll in Wisconsin

By N. M. ISABELLA

Assistant Maintenance Engineer, Wisconsin Highway Commission

IN 1905 the motor vehicle registration in Wisconsin was approximately 1,492. In 1923 there will be about 440,000, or an increase of approximately 28,000 per cent over 1905. Statistics show that the volume of business transacted over the highways today with motor vehicles exceeds that of the railroads. People combine business with pleasure and spend a good share of their time on the highway. Practically all important centers of population are now connected with freight and passenger bus lines.

This growth in highway transportation is, however, unfortunately accompanied by other features that affect the safety and comfort of the people. One of these is the auto accident. Whether it is avoidable or unavoidable, it plays an important role in highway transportation. If we reflect for a moment, we can readily understand why certain characteristics of human beings which are very noticeable in other walks of life should "come to the surface" in the driving of motor vehicles. When it is considered that one in every six persons owns and operates a motor vehicle, and that its use is extended to other members of the family, it is not surprising that accidents should

WISCONSIN HIGHWAY COMMISSION
Madison, Wisconsin

REPORT OF ACCIDENT

ON STATE TRUNK HIGHWAY NO. 32, Grant COUNTY.

1. Accident occurred the 22 day of October, 1923, at
10:30 o'clock P. M.

2. Location: In mile No. 62, at or near Spring
(Name some point such as R.R. Crossing, Bridge, School or Farm.)

3. How did accident occur? Loosening gear bolts and
on coming car ran into car driven
by E. Evers
(State whether on R.R. Crossing, straight Road, Curve, Right Angle Turn, Cross Road, Hill, Culvert or Bridge.)

4. Give license number of car or cars. 259-789 Wis-1922
(Give year, state and everything on license plate.)

5. Was car or cars speeding? No

6. If possible, give names and addresses of injured persons, if any, the nature of the injury, and the number of persons in the car or cars reported.
Mrs. E. Evers was slightly injured about
the legs

7. (a) Was the present condition of the highway in any way to blame for the accident? Yes. If so, in what way?
Loose sand

(c) How can future accidents be prevented at this place?
By graveling road

Signed A. E. Cole
Patrolman, Sec. No. 16

NOTE: Further information may be written on opposite side.

Fig. 1

A "Report of Accident" blank used by the Wisconsin Highway Commission in gathering data on accidents.

occur. These are to some extent due to the great diversity in the temperaments of the different drivers and users of the highway. A study of the causes and remedies for accidents is one of the important duties of the highway engineer. While the great majority of accidents are of such nature that they might have been avoided if proper precautions were taken, there are those that are due to some feature in the highway improperly constructed or located. For this reason it is all the more important that this matter be thoroughly studied.

The Wisconsin Highway Commission started in May, 1922, to investigate the number and causes of automobile accidents on the State Trunk Highways, which comprise 7,500 miles or about 10 per cent of the total rural mileage in the state. All patrolmen were supplied with a sufficient number of blanks to report all accidents occurring on his section. A copy of one of these blanks filled out is shown in Fig. 1. As soon as an accident occurred, one of these blanks was filled out and mailed to the main office where all reports were tabulated. A newspaper clipping service furnished reports on accidents in the few cases which were not covered by patrolmen. Some of these reports were also mailed in by other men connected with the highway work. These reports are tabulated and a summary



What happened when one driver attempted to pass another car going in the same direction on a narrow road. This highway is now being widened.

with brief comments is sent to the press at the end of each month. By bringing these figures before the public in this manner, it is believed that the number of accidents will be lessened.

In the following table (A) are shown the accidents from May 1, 1922, to December 31, 1922, by months:

TABLE A. TABULATION OF ACCIDENTS ON WISCONSIN STATE TRUNK HIGHWAYS—1922

Month.	Number of Accidents	Approx. No. Persons Involved	Number Killed	No. Seriously Injured	No. Slightly Injured	Persons Uninjured
May	46	161	5	10	31	115
June	88	142	6	43	54	39
July	171	600	14	45	148	393
Aug.	194	782	25	59	187	511
Sept.	198	664	12	53	158	441
Oct.	164	525	9	42	158	316
Nov.	132	444	12	30	123	279
Dec.	76	244	11	30	76	127
Totals ..	1069	3562	94	312	935	2221

Table B shows a summary of all the accidents separated by causes and by location.

There are probably several other causes for accidents which might be shown in Table B, but the writer believes that those shown cover the more common causes.

The following table (B), shows the total number of accidents during the year 1922, and their causes:

Total number of accidents.....	1,069
Number of people involved.....	3,562
Number of people killed.....	94
Number of people seriously injured.....	312
Number of people slightly injured.....	935
Accidents occurring on straight road.....	718
Accidents occurring at curves or corners.....	185
Accidents occurring at R. R. crossings.....	66
Accidents occurring at cross roads.....	62
Accidents occurring at miscellaneous places.....	38
Accidents due to reckless driving.....	631
Accidents due to improper lights.....	61
Accidents due to broken car mechanism.....	45
Accidents due to intoxicated drivers.....	40
Accidents due to weather conditions.....	46
Accidents due to cars on wrong side road.....	17
Accidents due to narrow culverts and bridges.....	9
Accidents due to miscellaneous causes.....	220

The above covers the time from May 1, 1922, to January 1, 1923.

The above reports cover only the State Trunk Highway System outside of cities having a population of 2,500 or more. The majority of the reports were furnished by the patrolmen, supplemented by reports from newspapers and other sources.

At first glance, it would seem out of reason that most of the accidents should occur on straight roads, but when one considers that the great majority of highway mileage is on straight roads, it is not so difficult to understand. There is also the fact that more drivers try to pass other cars on straight stretches than on any other part of the road. Reports show that the great majority of straight road accidents are due to one car's trying to pass another. It is often stated by railroad officials that the straight road is more dangerous than the railroad crossing. This, of course, is not true. Considering the 1922 accidents, we have a total of 1,069 accidents, 66 of which occurred at railroad crossings and the reports show that there was one death or serious injury to every 1.26 accidents occurring on railroad crossings and one death or serious injury to every 2.8 accidents occurring at other places on highways. In other words, the element of danger on the railroad crossings is twice as great as that on other parts of the highway. The writer, in giving these figures, is not attempting to justify the accidents occurring at places other than railroad crossings, but is bringing this out to show the necessity for grade separation on many of the crossings.

Table B also shows that the great majority of accidents are due to reckless or careless driving. There are many cases listed under "Reckless Driving," however, which are probably due to inexperienced drivers. Each year furnishes its crop of new drivers. Altogether too many of these do their practicing on the main highways where traffic is congested, instead of taking some unimportant high-



A comparatively sharp curve on one of Wisconsin's trunk highways equipped with guard rail to prevent accidents.

way. Looking over the list of different causes, one can readily see that the great majority of smashups could be avoided by taking proper precaution.

In quite a few instances during the past season pedestrians have been hit by automobiles at night. In practically every case this might have been avoided had the person walking used the left side of the highway instead of the right. Horse-drawn vehicles are another source of danger at night if proper lights are not displayed.

Motor vehicle transportation is here to stay and with the increasing volume of traffic each year, highway accidents are inevitable. It is the writer's belief, however, that they can be very materially decreased by systematically spreading the gospel of safe and sane driving.



One of the safety measures adopted by the Wisconsin Highway Commission is a black line marking the center of the pavement. This divides traffic and shows the driver the area to which he should confine himself.



A newly constructed bridge six miles north of Flagler, Colorado, supported by Armco culverts set in concrete footings four feet wide and eight feet deep.

Constructing Small Bridges for Heavy Traffic

How progressive Kit Carson County, Colorado, saves time and money by using corrugated iron culvert pipe as bridge piers.

MAKING extensive and permanent improvements on a county highway system with limited funds is a problem which faces a large percentage of the county commissioners of the United States. Any device or method of construction which operates to give greater service with lower cost finds favor with road commissioners who are trying to make both ends of their county highway fund meet.

The accompanying photographs illustrate an efficient and economic method of small bridge construction through the use of Armco ingot iron culverts as

bridge piers, which has been used with success in many parts of the west but particularly in Kit Carson County, Colorado.

County Commissioner G. W. Huntley has made several of these installations in the course of carrying out a rather extensive improvement program in the above county. The photo at the left shows a bridge located four miles south of Flagler, Colorado, while the one above, of similar construction, was built six miles north of the same city.

Fifteen-inch Armco culverts, filled with concrete and four reinforcing bars to each culvert, form the piers on both bridges. Two-by-two inch, angle-iron, sway braces with two and one-half foot drift bolts for 12 inch by 12 inch caps increase the factor of safety and complete the pier construction. Commissioner Huntley states that this has been found to be the ideal form of construction as it makes for a considerable saving on cement and form lumber.

The size of the concrete footing varies with the local conditions. In the bridge pictured at the left this footing is six feet deep and three feet wide. In the other bridge the footing is of heavier construction, being eight feet deep and four feet wide.

This form of pier construction is particularly adapted for use where protection is desired against teredo, ice floes, attrition, and floating debris.



Another bridge four miles south of Flagler, Colorado, showing supporting piers constructed of Armco culverts on concrete footings reinforced with angle iron braces, as described in the accompanying article.

Road Construction Aids Campers in North Carolina's National Forests

By VERNE RHOADES
Forest Supervisor, Asheville, N. C.

The United States Forest Service in building highways and trails and establishing camp sites in the Blue Ridge Mountain region is doing much to lure the tourist and camper into the National Forests of North Carolina.

SINCE 1911, when the United States Government began buying forest lands in the Southern Appalachian Mountains, there has been acquired to date approximately 400,000 acres in Western North Carolina. This amount represents about one-tenth of the total of mountain land in the State.

It is a matter of general knowledge that the chief reason for these purchases by the federal government is based on the need of maintaining a protective forest cover at the heads of navigable streams. That indeed is the primary function which these National Forests will fulfill. But there are other benefits both direct and indirect that present a stronger appeal to our imagination and arouse our active interest. One of these is found in the recreational possibilities which abound not only in the National Forests but on privately owned forest land as well.

There exist opportunities to hunt, fish, tramp, ride horseback, motor, and camp. But camping usually suggests the inclusion of all pleasures which have as their basis a love for the out-of-doors.

Camping has never had the same vogue in the Southern Appalachians among local inhabitants, or even among those who come up from the lowlands and the interior coastal plain, that it enjoys among

New England's pleasure seekers, who use their mountains and woods and lakes far more than we do ours. This may be, in part, due to differences in temperament, to accessibility from large centers of population, or to lack of good roads. As an illustration, good roads were threading New England long before highways were thought of in the more extensive wilds of the Southern Highlands. Thousands of New Englanders knew the White Mountains years ago, whereas, in comparison only few knew, with any degree of intimacy, the North Carolina mountains. Formerly it required a tedious journey to get into remote sections of the Blue Ridge. To reach the heart of its higher and more rugged spurs like the Black Mountains and the Pisgah Range was extremely difficult. Even today the crest line of the Great Smoky Mountains is inaccessible except at certain points.

The gradual construction of trails throughout the National Forests and the completion of good roads through many sections is rapidly overcoming the difficulties in the way of those who come to pass a summer or motor through the region. Isolation and remoteness are being eliminated with pick and shovel, forge and steel, and thundering dynamite. Along the open road now travels the tent



Motorists camping at Toe River Gap on the Mount Mitchell motor road, Pisgah National Forest, North Carolina.

dweller and others of his kind who seek a change from the unyielding pavement of the city street to the cushion of the forest path.

The U. S. Forest Service in administering these Eastern National Forests feels a deep sense of responsibility in its work. It has always endeavored to shape its policies so that large public benefits would eventually follow.

To encourage camping, and to prepare, insofar as limited funds permit, certain conveniences and sanitary arrangements is the constant endeavor. Though these Southern Appalachian Forests are young in point of government ownership, still they already offer tempting lures for the hiker, the camper, or the more ephemeral vacationist who motors by day and seeks the security of the hostelry by night.

At many places suitably chosen along the roads, or easily accessible to the main roads, camping sites have been and are now being developed for the convenience of the public. Along the Pisgah Motor Road, there are already half a dozen sites adjacent to the highway where one can pitch a tent and stay as long as the spirit bids before taking the road again. These sites are at varying elevations, the highest being 5,000 feet; the lowest 2,400 feet. Some of the sites are chosen for the views to be obtained from them; others are selected because of the intimate charm of the spots themselves. All possess the qualifications of good sites: fine spring water, sanitary conveniences, nearby fuel wood, and parking space for cars. Some are equipped with fireplaces whose wide mouths gape insistently for broiling steak and hot coffee made in the open.

The Frying Pan Gap camp site overlooks the Pink Bed Valley and the view



Boys breaking camp preparatory to another day's journey through North Carolina's national forests.

stretches far to the Blue Ridge and away to the southwestern mountains around Highlands. A half mile from here another camp will be established on the top of Big Bald, from whose furzy head the eye can sweep the entire horizon. Down the road a few miles the Pink Bed Site is ready at hand in a grassy old orchard skirted by a quiet stream, and from whose open spaces the tops of surrounding ridges are seen.

These camp sites are along the Pisgah Motor Road. Others have been established along the motor road to Mt. Mitchell, along the Yonahlassee Road from Linville to Blowing Rock, the Three States Road from Highlands to Walhalla, the Franklin Aquone Road across the backbone of the Nanatahala Range in the Nanatahala National Forest.

With these plans in mind the Forest Service, partly through its organization and partly in co-operation with cities and towns, hopes to help keep alive the innate love which people have for the woods.



From the top of Mount Mitchell the eye travels over the rugged world toward the west, beyond the confines of Pisgah National Forest, North Carolina.

The Relation of Good Roads to Social, Economic and Religious Development

A Sermon on Good Roads to *Highway Magazine* readers by the REV. J. M. BALLANTYNE, Th. M., Pastor of the First Baptist Church of Chelsea, Oklahoma

"Go through, go through the gates; prepare ye the way of the people; cast up, cast up the highway; gather out the stones; lift up a standard for the people."—Isaiah 62,10.

THE scientific definition of life, "The continuous adjustment of internal relations to external relations," has never been improved upon. The definition means, of course, that a man to live, and be comfortable and happy, must continuously adjust himself to such externals as climate, food, clothes, customs, conventionalities, etc.

Now good and bad roads are external relations to which we must ever be adjusting ourselves.

It should not be difficult to convince the average man that the establishment and maintenance of fine public highways through taxation is as essential for his maintenance as is the purchase, even at high prices, of stout shoes, warm and attractive clothes, wholesome food, or any other thing that he terms a necessity of life. What I am trying to say is that good roads are as much the necessities of life as are shoes, shelter, and food, and it is the object of this sermon to convince its readers that fine public highways are vitally connected with everything that goes to make life rich, materially, mentally, and religiously.

That this vital connection is true, no less a book than the Bible bears witness. The prophet Isaiah, when he wishes to describe the general and total breakdown of a nation, utters the significant statement, "The highways lie waste." That is enough; there is no need for further word painting. And when the Apostle John wishes to depict a perfect state, he describes a city whose streets are pure gold. And outside of the Bible in this every day world we are ever recognizing that good and bad roads are unerring indicators of various stages of prosperity and even morality in both towns and countries. For instance: the slums of a city are a dead give-away—their filth, their ugliness, their disorder, and gloom, are a sure material indication of some-



First Baptist Church, Marion, Kentucky, surrounded by a sea of mud, which makes attendance at Sunday worship difficult.

thing ignorant and vile and vicious in the character of the dwellers thereof.

While on the other hand, the establishment and maintenance of good roads bear a vital relation to the prosperous development of every institution that is operating for the well being and progress of any people in the world. When Dan Crawford went out to the center of darkest Africa and took up the work of the great missionary, Livingston, the very first thing that he taught the natives was just how to build good roads through the jungles. Good roads are to the civic body what veins and arteries are to the physical—they are the great distributing and contributing mediums for the maintenance and well-being in the community and city life of the Republic.

In the matter of agriculture, which is the prime industry of the world, good roads are so essential to its development that the whole system would collapse without their benefits. Good roads en-



The above photograph shows the rigors of getting to church in the isolated rural districts without good roads.

hance the value of land, increase the quality and quantity of farm products—decrease freight rates by an increase in the volume and regularity of exports, and bring products into contact with the great markets of the world. Lastly, where great highways are to be found there is always found the scientific type of farmer, who is able to cope intelligently with conditions.

Illustrations, or rather examples, can be produced that will readily verify the foregoing statements. Take, for instance, Tulsa County, Oklahoma, a county that has so perfected her highway system that the roadmen there are co-operating with other counties in the building of their roads. Before the highways were built, land that cannot be bought now for \$300 per acre was then selling for \$30 per acre. This land is situated eight and ten miles from any city. In high grade scientific farming Tulsa County is forging rapidly to the forefront.

Next, good roads are essential for the development of the home life, especially of the rural communities, because they increase those avenues which contribute their enriching and refining influences to those homes and families which would otherwise be isolated. The highway makes possible the automobile, the telephone, the telegraph, the postal service, the almost immediate service of the physician, and the hundred and one modern conveniences that put shock absorbers into the stark harshness of life.

By the highway, the farmer and his folk keep in touch with the great centers of social life and keep abreast of the affairs

of the world. By the highway isolation is destroyed. Man is a social animal and when deprived of the companionship of his fellows continuously, becomes morose, angular, eccentric, lopsided, and often altogether unbalanced. By the highway even insurance in the rural districts against fire is possible. Dallas County, Texas, has made this possible for farmers living on paved roads within a radius of 15 miles of the city limits. When a fire alarm is given over the telephone, the department responds at the rate of fifty miles an hour.

Also, good roads are essential for the proper establishment and maintenance of the instructional activities of the community. Schools, larger, finer, better equipped, and more efficiently manned, are possible only where highways are in good condition. Especially is this true in the rural districts.

This activity is so important that every opportunity should be seized to impress its significance. In the education of the average child there is bound up the success or failure of this great Republic. America can never rise any higher than the average intelligence of its people, because the people are the government, and how can it rise higher than itself? It has been brought out repeatedly by statistics that the vast majority of inmates of our jails are illiterates. Ignorance is the mother of crime. Crime and its effects cost many times more, annually, than the building and maintenance of our public highways. The good road is the open door of the school for the child.

Finally, good roads are essential for the building and maintenance of our churches, which are the institutions ordained by the Almighty for the care and culture of both the private and the public conscience. Who can doubt the importance of the church as a divine and essential institution? The very same arguments that demand good roads for the school are in order here only with a little fiercer emphasis. But no matter how important the church is, if one cannot reach it, if there is no way to it, then its effect is nothing. When men realize that the fundamentals of prosperity are not material, or social, or even intellectual, then will they build their highways into the sanctuary and learn that the fundamentals of prosperity are spiritual.



Irrigation and Drainage

Flood Control on the Mississippi

How automatic drainage gates prevent the reflooding of low-lying areas through back flow during fluctuating river levels.

CLOSELY allied with the problem of flood control in the lower Mississippi Valley is the problem of drainage of low-lying lands adjacent to the system of levees which hold back the waters of the Mississippi from the surrounding country during the flood stage. One of the important factors in this problem of land drainage is the prevention of back flow of water through the drain pipes.

Engineers engaged in the solving of the problem of high water control on the Mis-

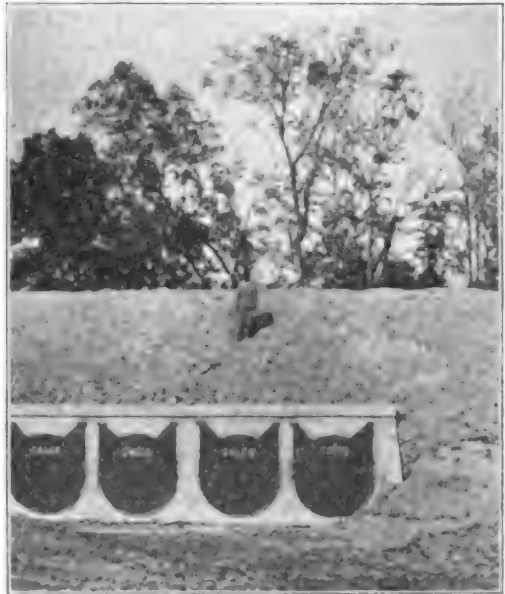


Photo No. 1. A battery of four Calco gates installed under the Northern Pacific Railway, Clarendon, Arkansas.

issippi have long known the necessity of preventing the recurrence of flooding the low areas back of the levees from the back water flow.

In many cases, the installation of automatic drainage gates on the river end of drain pipes has overcome this difficulty.

A typical example of such an installation is pictured herewith. Photograph No. 1 shows a battery of four Calco automatic drainage gates installed under the Missouri Pacific Railway at Clarendon, Arkansas.

These four gates were part of an order for the Clarendon Levee District. They were attached to 60 inch 10 gauge pipes, 80 feet long. Photo No. 2 shows a close-up view of the automatic drainage gates.

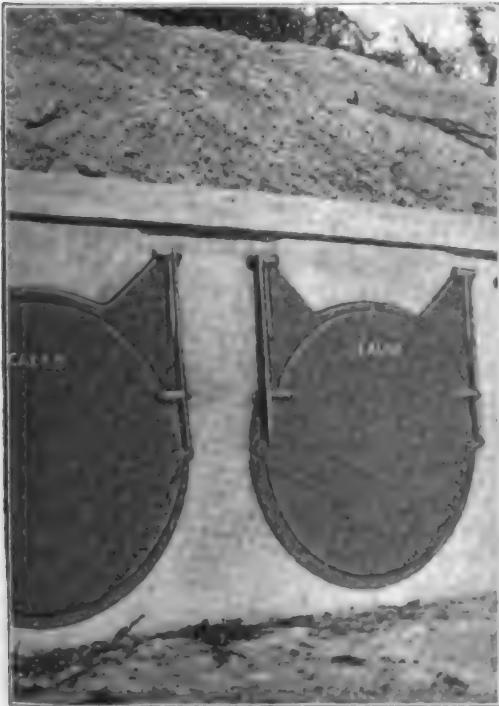


Photo No. 2. A close-up view of the 60-inch Calco automatic drainage gates installed in the Clarendon Levee District.

Big Irrigation Development Completed in Central Oregon

Nearly 16,000,000 acres of land in Deschutes county have been brought under water through the completion of a project which is featured by permanent construction, insuring low maintenance cost.

THE United States is now raising crops on a total of approximately 16,000,000 acres of irrigated land. This amount is nearly one-sixth of all the irrigated acreage in the world. By far the larger percentage of this area is in the western states and is the result of only 50 years of development. During the last 25 years millions of acres of sage brush and desert land have been brought under water in the western states and transformed into productive farms which support a prosperous and contented population and which help feed the growing urban centers of the East.

There are still 20,000,000 acres of arid land in the West susceptible to reclamation and irrigation and the work of turning these unproductive areas into irrigated farms is going steadily ahead.

The state of Oregon is rapidly carrying out a progressive irrigation program. Over sixty irrigation districts have been organized in this state covering an area of more than a million acres.

One of the most notable irrigation proj-

ects in Oregon or in any of the North-western states, from the standpoint of return per acre on investment, is the one now being completed by the Deschutes County Municipal Improvement District. This development lies west of the Deschutes River, north of Tumalo Creek, and seven miles northwest of Bend, the county seat of Deschutes County, in the region known as Central Oregon.

The most permanent type of construction possible has been adhered to throughout the building of this project, which insures an unusually low maintenance charge in the future.

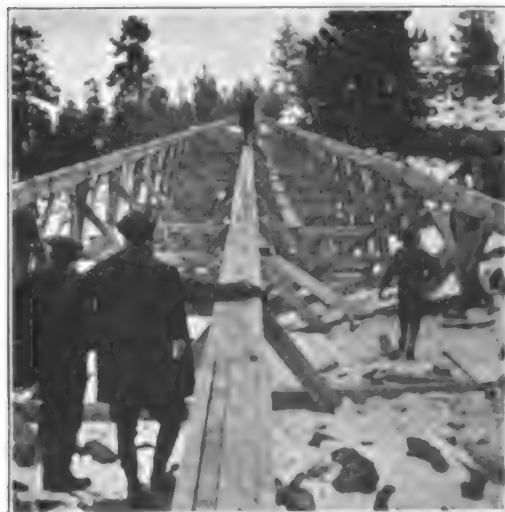
There is a total of 26,586 acres in the project, of which 15,400 are irrigable, and 7,808 acres have been under irrigation for the past eight years. The land is rolling and lies at an elevation of from 3,000 to 3,500 feet above sea level, with snow-capped mountains in view practically the year round, and with an abundance of timber for wood, posts, etc.

The soil is of the usual volcanic origin of the arid regions, mixed with sand, and is capable of producing excellent crops of grains, grasses, potatoes, and all kinds of root crops and vegetables.

This project was initiated in 1902 by the Columbia Southern Irrigation Company under the terms of the Carey Act. It was presented to the Desert Land Board, and a contract was entered into for the irrigation of 27,000 acres of land. The amount of water supplied was not sufficient, and in 1913 the project was taken over by the State to be completed by a Legislative appropriation of \$450,000 for the construction of the project, which was completed in 1913 and 1914.

In the early spring of 1915, the Tumalo reservoir leaked along the fault line on the east side. Due to these leaks it was necessary to build an additional canal from the Deschutes River to the Tumalo feed canal.

The new system involves a reservoir at Crescent Lake at a cost of approximately



Erecting the substructure of a twin flume on the old feed canal, Deschutes County, Oregon.



A section of Armco ingot iron flume following the course of the Deschutes River on the project described in the accompanying article.

\$100,000. It is provided with an outlet and inlet canal with two 5 by 6 foot cast-iron gates designed to pass 400 second feet. The spillway length is 100 feet. The total amount of storage in the lake will be 60,000 acre feet, with 32,000 acre feet impounded at the present time. The Crescent Lake storage reservoir is a natural and perfect reservoir, and this with the natural flow of Tumalo Creek, with ordinary seepage losses, will supply all the lands in the district with 3 acre feet of water.

The diversion dam is located on the Deschutes River within the city limits of Bend, Oregon. It is a concrete dam with a 140 foot spillway. It has five 6 by 6 foot steel gates with an additional flash board section for regulating the flow of the river. The concrete intake has three 4 by 6 foot steel gates provided with stands and screw lifts.

Directly below the dam is 812 feet of canal section with a rubble masonry wall on the lower side, rubble masonry lining on the upper side, and six inches of concrete lining in the bottom.

The total length of the canal is 4.97 miles, and the total cost throughout will aggregate \$550,000. There are four metal flumes on the canal, with a total length of 11,009 feet. All of these flumes are constructed of galvanized Armco ingot iron of 14 gauge metal.

The timber substructure is of unusually good construction and is supported by well-built rubble masonry piers. The siphon is 827 feet in length, and is a continuous wood stage pipe having a diameter of 6 feet 6 inches. It is supported by rubble masonry piers with saddles of the same material, built 10 feet center to center.

The tunnel is 747 feet in length with

finished dimensions of 7 by 7¼ feet, with concrete lining. The portals are built of rubble masonry.

The project was practically completed on May 1st, which will give a superabundance of water for the coming irrigation season.

The entire work has been directed and supervised by C. M. Redfield, Chief Engineer, who has been connected with irrigation work in the Central Oregon district for the past 19 years.

The United Contract Company, of Portland, Oregon, took the contract for construction, under the supervision of Mr. William Ellis, and during a recent inspection of this and other irrigation projects in Oregon by Governor Pierce and the State Securities Commission, in company with a special committee appointed by the Legislature, this was pronounced the finest project they inspected in the State, from the standpoint of permanency and potential productiveness.

Fred N. Wallace, who has been Project



Laying the Armco ingot iron flume on the twin flume substructure pictured on page 14.



Flume No. 1 crossing a creek bed. This is part of the 11,000 feet of Armco flume used on the Deschutes project.

Manager of the development ever since its inception, is recognized as one of the most competent project managers in the West.

G. W. Hobson, is Chairman of the Board of Directors, which includes R. H. Bayley, Emil Anderson, and C. H. Hatch. They have given their undivided time and attention in helping to make this project one that would be a pride to the State and a model for other districts to follow.

In 1914 this district installed about a mile of galvanized Armco ingot iron flume No. 120, of 16 gauge metal, which has been in constant use since its installation. It is said by many engineers that the conditions under which this metal flume has been in service were the most severe that it was possible to find, on account of the silt and sand in the water. A recent examination of this nine-year-old flume by the engineers and directors of the district, showed it to be in perfect condition, and as a result it was taken down and placed in another part of the district as a twin flume. It was the unusually good service given by this metal flume, installed in 1914, that had most to do with the district adopting Armco ingot iron flume for the new extension. The maintenance expense of the metal flume installed nine years ago has been practically nothing.

The price of land for sale in this district is unusually low in comparison with prices in many other districts in the West, and to actual settlers who want to make their homes on this project unusually liberal terms are offered.

Fred N. Wallace, the Project Manager, whose address is Tumalo, Oregon, will give any additional information desired. The present farmers under the project are prosperous and satisfied.

• Publication •

Victory Highway Work in Kansas

A MOVEMENT to line the Victory Highway from New York to San Francisco with trees dedicated to those who lost their lives in the world war, was initiated at Topeka, Kansas, recently when 32 pin oaks were planted, fifty feet apart, on a stretch of the highway near Topeka. The Topeka Women's Club was in charge of the program, which was attended by about 300 persons, including H. G. West of Topeka, president of the Victory Highway Association; G. W. Stansfield, Topeka, secretary, and Mrs. C. A. Wolf, Topeka, a vice-president. Bishop James Wise of the Episcopal cathedral here, delivered the dedicatory address.

The plan under way is to have each county through which the highway passes, plant trees on its portion. The trees planted today were dedicated to the 32 Shawnee county boys who made the supreme sacrifice in the world war.



March 1, 1923. Looking East on one of the main canals as the flume laying was completed.



ARMCO



Culverts and Washing Machines

Did it ever occur to you that a washing machine has the same excuse for rusting that a culvert has? Both are subject to a succession of wet spells and dry spells and the alkali contained in soap and washing powders is duplicated by the alkali of the soil.

A number of leading washing machine manufacturers have adopted ARMCO Ingot Iron for the sheet metal parts of their machines, because its remarkable purity and evenness of texture make it highly rust resistant.

This fact should be significant to the highway engineer or constructor who wants rust-resisting culverts. May we send you the proof that ARMCO Ingot Iron *does* resist rust?



The American Rolling Mill Co.
Middletown, Ohio

Fleasure Cars had Solid Tires



Photograph
taken in 1910

when the first photograph
was taken in 1910



Photograph
taken in 1922

Styles in cars and tires
had changed by 1922

but the **ARMCO CULVERT**
remains unchanged with no trace of 12 years usage



The HIGHWAY MAGAZINE



August
1923

**Write to the nearest manufacturers for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equip. Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Calgary, Vancouver, Vernon

The HIGHWAY MAGAZINE

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VOL. XIV.

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No. 7

"RUBBER BRICK" STREET PAVING

An interesting and novel experiment has been made in Holborn, England, where a street was paved with rubber bricks. This is an entirely new method invented by E. F. Spurrell, Borough Surveyor. At the right Mr. Spurrell is shown superintending the work of laying the rubber pavement.

Below (center) a typical scene on a rubber plantation in the Far East—natives planting rubber trees.



The rubber blocks (or bricks) are shown at the left. They are grooved and are laid to fit into each other upon a base of concrete. The blocks used are similar to the wooden block ordinarily used for street paving, and measure $9 \times 4\frac{1}{4} \times 3$ inches. It is claimed that this rubber pavement can be placed on the market at a price to compete with the ordinary creosoted wood block, when it is taken into consideration that the composition blocks are noiseless and have an estimated life of 15 years.



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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

In Behalf of the Highway Engineer

By MILLARD CROWDUS
Assistant City Engineer, Nashville, Tennessee

TO have streets we must have Plans, and, to have Plans it is necessary to have Surveys of the aforesaid streets. And, at a very great risk of life and limb, and oftentimes with a total loss of Dignity, as well as a sacrifice of any chance of Future Salvation, the Engineering Corps goes out, and in spite of every handicap of Nature and Mankind comes back with a book full of rain-spotted, mud flecked, endlessly fatiguing figures. This ends the first chapter; and it is now the cold hearted, cynical draftsman who must create from the precious data the BEST possible roadway for the flivvers of the Tax Payers.

"Still measuring? You fellows already measured this street twice, takes a whole heap of measuring I guess!" WHAM! (Justifiable Homicide!)

Yes, it takes a lot of measuring, but s'long as the sunburned wind-bitten, rain drenched young fellow disdains to answer, I suppose I shall have to give the secret to the sarcastic old loafer. To build a block or a mile of street, or modern, permanent highway, there are many operations to be performed, and in the

case of an unimproved city street they are as follows, in the order named:

1. The survey
 - (a) establishing the correct alignment.
 - (b) cross sectioning, level survey to determine the amount of yardage, and to fix the best grade possible.
2. Lines and Grade stakes given for the various Public Utilities to set their Poles, Water and Gas Pipes, Meters, etc.
3. Lines and Grades for the New Concrete Curbing.
4. Grades for the new Concrete Gutters.
5. First Grade stakes for the contractor to excavate the roadway.
6. Additional Grade stakes for trimming the road bed.
7. Final Grade stakes for the finished surface of Paving.
8. The final inspection and the proportional measurement of the new paving.

Not to mention the thousand and one things that crop up at the eleventh hour; wet-weather springs, sewerage, leaks, wildcat pipes, irate property owners, faulty sub-grade-washouts, and so on ad infinitum. And, every two weeks the partial estimate for the contractors.

Yes, mister, it does take a "heap of measuring."

All this the patient plodding fellow in khaki and muddy boots could have told you, but if he stopped to answer every idle, combative questioner, why we'd NEVER get any streets built. (You can't explain to a....!).

Pshaw, boys, they're yelling for Grades on Helavava Ave. Let's go!

No Detours in Maine

MAINE is to be, as far as possible, a state of no road detours. Detours around construction work are to be avoided hereafter by inserting in all future contracts that the contractor keep his road open and in as good condition for traffic as possible. It will cost more to build roads in this manner but the responsibility to the public to maintain traffic routes with as little inconvenience as possible will certainly justify the added expenditure on construction costs.

Farm Economics and the Highway Program

By ALLEN D. ALBERT

Mr. Albert, the author of the following article, specially written for The Highway Magazine, lives on a farm in Edgar County, Illinois. He is also the author of many social studies and articles, chief among which is, "The Automobile as a Social Factor," published in Scribner's Magazine, July, 1922. For further details, see "Who's Who in America."

ONE of my neighbors in the State of Illinois lives half a mile from the Chicago highway. His private lane leading to this main road has given him a good deal of trouble. He owns a span of horses and a large six-cylinder automobile.

"If I can't get that lane fixed," he said one morning, "it would be better for me to move my house nearer to the Chicago road."

The above statement illustrates the new attitude of the farmer. Good roads are no longer debatable. He does not stop to analyze his wants. Hard roads may seem a luxury, pure and simple, to some people. But the farmer wants them—no matter who pays for them as long as he doesn't have to.

To the farmer, of all men, good roads are not luxuries.

The only thing that is more important to him than getting to market is getting stuff from market. The economic calculations of his household have changed almost as largely as those of the city man.

The farmer used to buy for his table very little besides sugar, spices, coffee,



A main highway in Illinois boasting a street car line, as shown at the left, but practically impassable to motor vehicles or heavy trucks.

salt, and a little store candy. The farm produced cereals, vegetables, meat, eggs, fruit, and honey.

Now he buys oranges and grapefruit, salt fish, certain dried fruits such as prunes, and the more modern farmer adds lettuce and fresh vegetables when his own gardens are not yielding.

Shut him in by bad roads, as he used to be shut in and the lack of variety in his food will affect him precisely as it affects the city man.

Bad roads cripple the farmer throughout the year in his work. It happens that from the first crop of hay to the harvesting of late turnips, the roads are likely to be more dry than at any other time of the year. But a poor road may have holes in it hub-deep in August, which are filled with water. Hauling fertilizer, limestone, coal, cement, and lumber for the farm has to be done at other seasons, usually when the roads are at their worst.

If his automobile can be used at all, it can be used to widen his market. In the United States small towns are about six miles apart on the more traveled thoroughfares. Good-sized towns are about



Drainage is a prime factor in highway construction. The Armco ingot iron culvert shown above affords adequate drainage on this country road.

The Highway Magazine

twenty miles apart. Great cities are about 300 miles apart. A Ford and a truck-body will put almost any farmer within reach of two or three good buying centers—if the roads are passable.

This statement means more than may appear on first sight. In my own experience I have had but a single offer for hay during an entire season from any buyer in the town nearest my home. The explanation of such a situation may be logical without being remunerative, but the fact remains that if I had depended upon that one market I must have taken that offer or let my hay rot. There are two markets not much farther away. To one of them the distance is 20 miles, to the other 37 miles. Reaching the latter, more distant market was easy because of the paved road. Consequently I had two good chances to sell my hay and when finally sold it yielded more than twice as much as that single offer from the buyer nearest my farm.

Getting to and from market centers is more important to the farmer socially than economically. We do not have "B'Gosh farmers" in Illinois. I do not know of any state that has. Our farmers take the daily papers, read the magazines, wear clothes like other out-of-doors folk, and have generally about the same interests as the publishers of city newspapers.

With bad weather, the rural free delivery is delayed. The carrier ordinarily



A paved highway in southern Illinois which brings the market much closer to the farm via the motor truck.



Under deep earth fills or heavy pavements, Armco culverts are a standard drainage structure.

ends his run at 11 in the morning. Unless the roads are excellent, a week of heavy rains will put his car in the shed and force the mail man to cover his route on a little two-wheeled sulky. This means 3 or 4 o'clock in the afternoon before his work is done—and a corresponding delay of the mail for the farmers towards the end of the route.

Our farmers go to church, visit in town, attend the movies moderately, patronize the dentist, and do not count Saturday afternoon wasted if spent on the "Square."

Good roads and an automobile make the farmer and the doctor near neighbors. They put the older children in the town high school. They enable the girl, home from Normal, and the boy, home from agricultural college, to get to the country club and play golf. They increase social intercourse between relatives and friends. They make possible practically all the co-operative movements we have in mind as we cite the farm bureau and the home science clubs.

Do not think this is far-fetched. Some of the most energetic workers for civic progress of my acquaintance, some of the most stalwart factors in party and independent politics, are men and women who motor several miles to get to the meetings. One circumstance further ought to be stated. Any comprehensive system of good roads for the farmer is altogether out of the question if he has to pay the whole bill. It could never be achieved. His money income is surprisingly low. That does not mean that his goods in-

come is low—far from it. But modern roads must be built by contract, not by the working out of taxes, and contracts require cash.

The barriers against the farmer, economically and socially, must have stayed fixed, without some such program of road-building as New York State undertook in 1910 and many other states have since imitated. The farmer pays out in time and money a disproportionate share when he builds his own lane. He must expect to bear a large share of the cost of main highways.

He cannot do more than that so it will help the cause of better roads generally if city friends of the movement for better roads will only comprehend that the automobile has made branch highways almost as important to the town as to the country, and that an adequate road program will reach far beyond the better known tourist routes.

EDITOR'S NOTE: This is the first of a series of articles covering the various aspects of the highway transportation problem, written by prominent men and women of the United States and Canada, who have long been identified with the Good Roads Movement in America.

The second article in the series, entitled "Good Roads and Their Effect on the Farm Woman's Life," which will appear in the September issue, was written exclusively for *The Highway Magazine* by Mrs. Mary E. Wood, farm woman, contractor, gravel pit owner, and an active worker in many good roads campaigns.

Transporting a 92-Foot Pole

THE cover design this month shows a 92-foot pole being transported a distance of twenty miles by two motor trucks to Pit River Power Plant No. 1, in California. This was a very difficult undertaking, and required considerable ingenuity on the part of both drivers. A powerful siren was used by the front driver in signaling the proper course to be followed by the rear driver. Failure to work their trucks together would have caused serious trouble at many turns.

W. J. CROSBY

Wilson Dam Construction Work Keeps Up With Estimate

WORK on the Wilson Dam at Muscle Shoals is 40 per cent complete. Progress is closely following the preliminary estimate. In March 34,586 cubic yards of concrete were put in, of which 17,293 cubic yards went into the dam, 17,000 into the power house, and the remainder into the lock.

Working conditions have been particularly favorable. There have been few days with rainfall enough to interfere with work, and no high water. Labor turnover has been small and the productivity of labor is much higher than two years ago. There has been no trouble in getting materials, since sand and aggregate are being secured locally by the regular working force and there has been no difficulty in maintaining an ample reserve of cement, the only material shipped in.



Two typical installations of Armco culverts used for lateral drainage on crossroads. Their great elasticity and resiliency enable them to withstand the shock of heavy farm tractors under very shallow fills.

The West's Most Unique Highway

By
Leland C. Lewis

TRAVELERS who have made the motor trip along the rim of the Mexican border in Arizona and Southern California, will never fail to recount their experience on that stretch from Yuma in the former state to Holtville in the latter.

After crossing the sluggish Colorado at Yuma on the gigantic Ocean-to-Ocean Highway Bridge, the next eight miles is through the lands belonging to the Yuma tribe of Indians.

Signs of civilization are left behind with the crossing of the Southern Pacific Railroad tracks, and soon the car is again laboring through heavy sand. Stretching from the South as far as the eye can see, and to the North for a considerable distance, is a ridge of towering sand dunes, as stark and bare as Sahara's waste save for a few sprigs of dwarf mesquite and an occasional shaft of Sahara cacti.

Just as the tourist begins to wonder whether or not it will be possible to go any farther, something new in the line of road construction looms up ahead of him. It is the famous Holtville-Yuma plank road, an innovation in highway building, that was completed shortly before the nation entered the late war.

Laid side by side, with no under trussing, are two by six planks, six feet in length, that are held together with a piece of strap iron on both sides and another in the middle, to prevent creeping. The planks have been given a coating of creosote, and show little wear considering the length of time they have endured the tor-

rid summer heat and the terrific sandstorms. The road is built in all defiance of the laws of civil engineering, and appears as though a transit was never used at any time during its construction. Signs cautioning drivers to maintain reasonable speeds are unnecessary, as the curves are so abrupt and the track so narrow, that any foolhardy action would immediately precipitate a machine headlong into the loose sand which would necessitate men and mules and hours of time to extricate it.

The surrounding sand is drifted into hummocks of the most fantastic shapes, and is so finely granulated that it would not hold up as a base for concrete. It takes only a slight breeze to send it whirling over the planks thus obstructing traffic. For that reason scrapers and drags are stationed at intervals so that the road crew may have easy access to them.

The last remaining miles to Yuma Well are perhaps the most inspiring of the trip.

On going down a steep decline, one comes to the first well, a distance of 22 miles from Yuma. The California Highway Commission keeps men stationed at this point to attend to the upkeep of the road, and to aid travelers. A number of frame buildings house the men, and corrals and stables nearby provide accommodation for horses and stock.

During the present summer a splendid highway will be completed over the entire route, and the sixty odd miles that now require a good four hours to traverse will easily be made in two and a half,

County Road District Maintains Corporation Yard

Supervisor Cunningham of Sonoma County, California, inaugurates a reform in road equipment storage which effects a substantial saving in materials and lengthens the life of tools and high priced machinery.

CORPORATION yards," as maintained by large construction companies and city street departments for the storage and care of machinery and materials, have been fairly common for some time, but they are comparatively unknown in connection with county road work.

County commissioners or supervisors, lacking facilities for housing their supplies and equipment, usually assemble the road machinery belonging to their districts on some vacant lot which is centrally or conveniently located, and there let it stand unsheltered until it is next required. Road materials and supplies are hauled to the same location or left at the sides of the roads until needed. Some materials, such as crushed rock, sand, and gravel, are none the worse for exposure, but others are of such character as to rapidly depreciate under exposed conditions. The annual loss to the counties from this source undoubtedly amounts to many thousands of dollars.

W. L. Cunningham, Supervisor of District No. 3, Sonoma County, Calif., had a long experience as a practical farmer before he took charge of four hundred and seventy miles of county roads. One of the things he realized during his farming experience was the tremendous losses that many farmers sustained by leaving



A corner of the tool shed in connection with the Sonoma County Corporation yard.

their tools and machinery exposed to the weather. A mower or planter for which a good price had been paid, and which worked perfectly during its first season, required expensive overhauling after a winter under an apple tree, new parts were frequently required, involving expensive and vexatious delays, and about the third year of its use the machine went to the scrap heap and had to be replaced. On the other hand, some farmers provided cheap but weather-tight wagon and tool houses, kept their machines painted and oiled and prolonged their service by two or three hundred per cent.

It seemed to Mr. Cunningham that



A general view of the Corporation yard showing the truck sheds, tool house in close proximity to the railroad siding.



Supervisors A. D. Goddard, left, and W. L. Cunningham, right, Sonoma County, California.

exactly the same principles should be applied to the care and use of road machinery. Therefore, he acquired for his district a lot in Santa Rosa, which is near the center of operations and which was located on a railroad siding. Several cheap but substantial buildings of corrugated iron were erected, a caretaker employed and operations begun. The caretaker is a capable mechanic, and he puts in most of his time painting and oiling and otherwise caring for the machinery, and in effecting minor repairs. Every machine and vehicle is completely overhauled once a year and repainted every two years. The result is that much of the county's equipment which is several years old looks as good as new, and it is always ready to be sent out when needed.

The county maintains a machine shop where important repairs are carried out, but the hundred and one minor ailments which occur to put machinery out of commission are all remedied at the yard, at no additional expense to the district.

Some of the articles other than machinery which are carried at the yard are cement, nails, Armco corrugated pipe, lumber, etc. When any road structure, as for instance, a wooden bridge or guard rail is taken down, the materials are sent to the yard, to be used over again, if suitable, and if not, to be sent to the County Detention Home for fuel. Corrugated pipe is sometimes brought in in this way and used elsewhere when needed.

Mr. Cunningham has fourteen roadmasters working under his direction. Every one of them comes to the yard for all his supplies. The roadmen buy nothing themselves. This makes quantity purchasing and lower prices possible.

In addition to the four hundred and seventy miles of county roads in the district, there is a large mileage which has not been accepted by the county, but which is nevertheless a part of the highway system. These roads have to be maintained by the landowners, but the county endeavors to assist in every way possible that does not involve a direct expenditure of funds.

The constructive idea on which the yard is operated involves purchasing, distribution and preservation; and there can be no question of the economies effected. Mr. Cunningham's district is exceptionally favorable to the maintenance of such an establishment. Nevertheless, this innovation in county road work is one that could be adopted with profit in thousands of other places.



A truck train loaded with 4,000 feet of Armco culverts en route to points of installation in California.

Building County Roads Without Bonds

By A. H. MORTON

Special Correspondent for The Highway Magazine

How Butler County, Alabama, has built and maintained an adequate highway system without issuing bonds.



Two typical examples of the roads of Butler County, Alabama, before Probate Judge H. D. Lampley began his campaign for better roads in 1910. Left: Note the logs used in extricating a stalled truck. Right: a 75-foot stretch of water-logged road, due to lack of adequate drainage.

CAN a county build and maintain good roads and stay out of debt? Judge C. F. Winkler of Greenville, Butler County, Alabama, who also holds the position of President of the County Judges' Association of Alabama, states that it can be done and points to the record of his home county as proof of the assertion.

Because one man had vision and the strength of purpose to fight aggressively, for what later was proved to be the proper course of action, Butler County today enjoys finer roads than contiguous counties which have voted bonds. Furthermore, at the end of the fiscal year, September, 1922, with taxes due in October, Butler County had \$14,500 in the treasury and absolutely no outstanding warrants or obligations.

Few counties in the United States can boast of as fine a record, yet it must not be supposed that this record "just happened." It is the result of a ten-year fight against big odds.

In 1910, many Alabama counties realized the need for better roads, and determined to have them at any cost, and road bonds were enthusiastically voted all the way from Mobile to the Tennessee River.

Too little thought and care was given to the disposal of the money, with the result that, today, too many counties have more debts than roads.

Butler County, like the others, climbed on the band wagon and voted \$155,000 worth of bonds.

At this point, H. D. Lampley, Probate Judge of Butler County, took an unusual attitude for a public official. He opposed the bond issue on the ground that it was unnecessary, stating that Butler County could have good highways without voting bonds. Furthermore, he stated that he would not issue the bonds even after they were voted, and he never did, notwithstanding the fact that the feeling against his stand grew so bitter that he was threatened with impeachment and personal violence. But they don't feel that way now, and today, 13 years later, Butler County has still authorized but has not issued \$155,000 worth of bonds.

Butler County also has its roads—more and better roads than surrounding counties, for Judge Lampley has proved that he was not an obstructionist, but a man with vision, sound judgment and the ability to transform his ideas into actualities.

In 1910, the assessed valuation of the

county was about \$4,000,000. Today it is about \$8,000,000. The county tax rate, based on 60 per cent of the assessed valuation, is 13½ mills, six of which go to the schools, five to the county general fund and 2½ mills to the road and bridge fund. From 1910 to 1915 only, a special road tax of 2½ mills was authorized to meet bond interest. The state also gave the county \$2,000 a year up to 1912.

With this revenue at his disposal, Judge Lampley waited until he had accumulated about \$80,000. Part of the general fund was transferred to the road fund, and then he started building the roads. He organized a road department and placed it in charge of Mr. R. S. Corry, a civil engineer, who is still in charge.

In 1920, Judge Lampley died and the present judge, Hon. C. F. Winkler, filled out his unexpired term and was himself elected in 1922. Judge Winkler has the same ideas and policies as his predecessor in regard to public expenditures, and takes great pride in his county's unique financial condition. He has imbued every county official with a spirit opposed to waste and extravagance, and today Butler County is in even better condition financially than when Judge Lampley died.

Did Butler County get its roads? Yes—130 miles of well drained sand-clay roads, 24 feet in width, and 15 modern steel bridges, maintained at a cost of \$80



A typical section of one of Butler County's highways after Judge Lampley succeeded in building "roads without bonds."

per mile per annum, and in 1922 the county expended \$31,000 on additions and improvements.

Furthermore, since 1910 the county has established consolidated schools and expended money for tick eradication. And yet, in September, 1922, the end of the fiscal year, with taxes due in October, Butler County had \$14,500 in the treasury and absolutely no outstanding warrants or obligations.



Another section of Butler County's 130 miles of well drained sand clay roads, built without bonds.

Army Supplies Aid Road Building Program

APPROXIMATELY \$190,000,000 worth of road building machinery and other supplies from the surplus war material of the army, including 30,000 motor vehicles, have been allotted by the Bureau of Public Roads, United States Department of Agriculture. This material, of which approximately \$150,000,000 worth has been delivered, says the bureau in its annual report, has enabled many states to organize and equip maintenance divisions to patrol the entire state road system.

The largest item of materials delivered consisted of shop machinery and shop tools and equipment. This enabled the state highway departments to equip shops for reconditioning and repairing motor vehicles and other motor-driven machinery received from the government.

Delivering a Big Dollar's Worth of Roadwork

By R. A. FRANKLIN

Special Correspondent for The Highway Magazine]

How a Minnesota contracting firm, through organization, efficiency and hard work, completed a graveling job strictly in accordance with the state specifications at 37 per cent less than the state engineer's estimate.

A FEW years ago, Minnesota inaugurated a plan whereby a seven thousand mile system of state roads is to be constructed and maintained entirely under state supervision, and paid for with special State Highway Funds supplemented by the usual Federal aid.

Commissioner Babcock has endeavored from the start to see that the tax payers received the worth of their money in more and more miles of well constructed and well maintained roads. In pursuance of this object, all jobs are left to the lowest bidder and must be carried out according to specifications prepared by competent engineers.

In the fall of 1922, in accordance with this policy of carrying on winter roadwork in spite of climatic handicaps, he advertised for bids on various projects. Among these was a fifteen mile stretch of graveling on Trunk Highway No. 22, between Gaylord and St. Peter, which was to be completed during the coming winter.

When the bids were opened it was found that the lowest bidders were the Connelly Contracting Company of St. Paul, their bid being \$49,900. Since the engineer's estimate, based upon the usual rates for this class of work, was \$83,000, it can be seen that the saving to the state would be the surprisingly large sum of \$33,100, or about 37 per cent.

Other contracting companies and truck



The Briggs farmhouse, which was leased by the Connelly firm for the use of some of its men; also the special filling station installed by the Standard Oil Company for convenience in filling trucks.

owners of the Twin Cities held indignation meetings and protested glibly and volubly, stating that it could not be done; 'twas impossible to accomplish the task at any such price without great loss to the firm in charge; they declared that nobody could make any money at such rates, etc., etc., ad lib.

But the Connelly people went serenely ahead with their plans and got on the job as per agreement. They had already reinforced their truck frames with heavy steel I-beams and they now built up their



The Connelly fleet of trucks used on the St. Peter-Gaylord contract and the garage leased for maintenance work on the trucks



The spreader and caterpillar tractor used on the St. Peter-Gaylord winter contract job.

truck bodies one-third more than their original height in order to handle the largest possible amount of gravel and still comply with that part of the state engineer's specifications which required that all gravel be hauled in "water-level" loads, i. e., in loads not heaped up but level with the tops of the truck bodies, so that there need be no less gravel delivered where the trucks dumped than was loaded at the pit.

They had agreed to do this hauling at 17 cents for the first yard mile, with 4 cents additional beyond the mile point. Therefore, they must, in order to make a paying job of it, haul as many yards as possible on each trip from pit to road, especially as the average length of the haul was twelve miles.

Another item of preparedness accomplished by the contractors was the preparation of the road over which the hauling had to be done. During the fall they worked with shapers, graders and tractors to keep the road grade in the best possible shape at all times; so that when the frost did put in an appearance, they had a fifteen mile stretch of as fine and smooth a roadbed as one could wish. When the gravel hauling began, the day after Christmas, it was as smooth as a race track, and as hard as pavement, and the heavily laden trucks traversed it as easily as if it were actually paved.

That they might be sure of keeping within the time limit on their job, the

company arranged for two eight-hour shifts of workers, thus keeping busy their expensive machinery and fleet of trucks sixteen hours out of every twenty-four.

Another efficiency stunt of this firm was the leasing of a farmhouse, a hotel, a restaurant and a garage, the first two of which were put in the charge of a skilled personnel of their own choosing. They thus made sure of the comfort and well being of all their employees and also of the presence of expert mechanics to keep ever watchful eyes on the necessary trucks, tractors, graders, shapers, steam-shovels, etc., which must be on the job so constantly that there was no time to be spared for breakdowns which could be avoided by the "stitch-in-time" method.

And they did all this at a considerably less cost than similar services would command from outside parties, as well as incidentally adding to the *esprit-de-corps* of the members of their organization.

As they used \$5,000 worth of gasoline every month, the Standard Oil Company installed a 1,000-gallon filling station for their use at the Briggs farmhouse, which made it convenient to satisfy the fuel demand of the trucks near the pit.

With the hauling and spreading of the necessary 22,400 yards of gravel successfully accomplished, they are sure of more winter work in the future, and the State of Minnesota is assured of fulfilled contracts at little more than half the usual outlay, consummated with efficiency, foresight, and strict attention to details.



View showing the gravel pit and method of using horses to pull the load of trucks up the incline.

Irrigation and Drainage

An illustration at the top of the page shows a long, straight irrigation flume on the left, supported by a series of wooden trestles. To the right, a tunnel or culvert is shown passing through a hillside, with water flowing out of its end.

Prairie Land Irrigation in Western Washington

By EARL F. DICKINSON

Special Correspondent for The Highway Magazine

The Carstairs Prairie irrigation project in Mason County will bring a thousand acres of fertile land under water at the extremely low cost of \$16.50 per acre.



Flumes are the arteries of the irrigation project. The above photo shows a large Armco ingot iron flume built on heavy wooden framework with concrete base.

DIRECTOR D. A. SCOTT, State Department of Conservation and Development of the State of Washington, states the following in connection with the proposed irrigation of Carstairs Prairie, Mason County:

"After a careful investigation of the Carstairs Prairie irrigation project by Hon. Marvin Chase, Supervisor of Hydraulics, Ivan E. Goodner, Chief Engineer of the Reclamation District, and myself, we had Mr. Lars Langloe, Assistant Engineer of the Reclamation Division, make careful reconnaissance of said project. We desire to state that we can heartily recommend such development and our department will gladly do

what we can in the promotion of same."

The project contemplates the irrigation of approximately 1,000 acres of prairie and semi-prairie lands on Carstairs Prairie in Mason County, with Bingman Creek as the source of the water supply.

The soil of the prairie and adjacent timber areas is a high class, deep prairie soil, somewhat superior in quality to the average soil of the irrigated Yelm Prairie in Thurston County. It is somewhat gravelly but, as has been proved in Yelm, when irrigated, the land produces profitable crops of small fruits, root crops, strawberries, grains, hay and general farm crops.

All things considered, it would seem



An Armco flume crossing a river in Washington on a high wooden substructure.

that the project is feasible from every point of view and should prove an extremely economical development.

Estimates place the total cost of con-

struction at \$16,500. If the 600 acres that are most easily irrigated were irrigated at this cost, the cost per acre will be \$27.50; while if the total possible 1,000 acres are brought under water, as is planned, the cost will be \$16.50 per acre, the cheapest irrigation in the state.

Measurements made by Mr. Bartholet of the State Department during the extreme low water stage this season, show a minimum discharge of 38 second feet. As 20 second feet are sufficient for the acreage it is apparent that there is a superabundance of water.

Land of this type is proving extremely productive at both Yelm and Sequim. In fact, it is proving so satisfactory at Sequim that work has been started to bring 7,000 acres more under irrigation on this project. Prairie land can be cleared of small pines and brought under irrigation in this instance, for approximately one-third the cost of clearing and irrigating cut-over land.

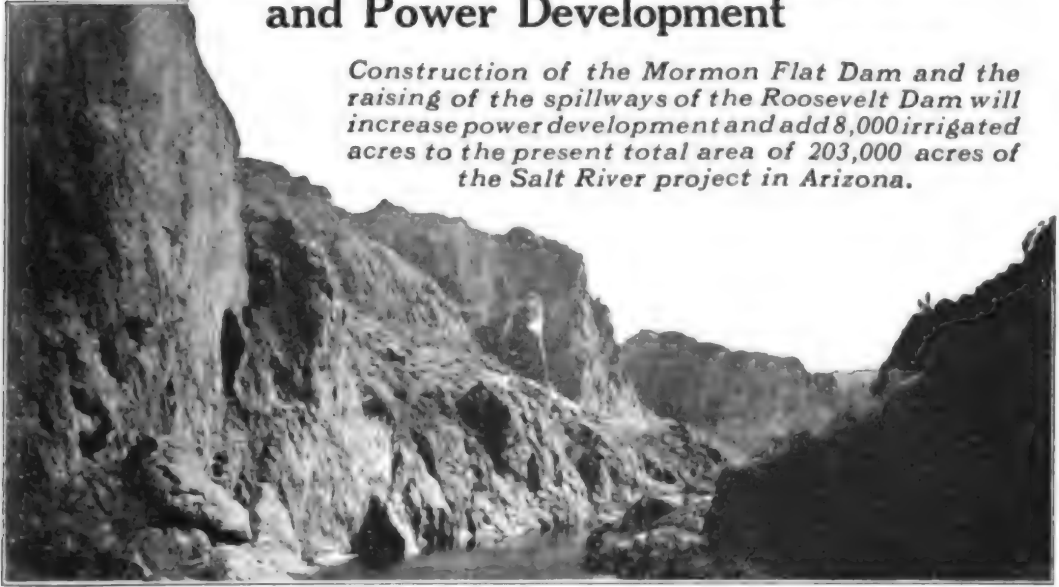
Irrigation is going to be the big factor in producing crops in Western Washington as soon as its value is known and much land which is now considered practically worthless for agricultural purposes will be converted into some of the highest producing land in the state.



Making a connection between an irrigation ditch and an Armco ingot iron flume, on a large irrigation project in western Washington.

Salt River Valley Project Aids Irrigation and Power Development

Construction of the Mormon Flat Dam and the raising of the spillways of the Roosevelt Dam will increase power development and add 8,000 irrigated acres to the present total area of 203,000 acres of the Salt River project in Arizona.



The site of the Mormon Flat Dam, Salt River Valley, Arizona.

WITH a total of 203,000 acres of land, now producing bumper crops as a result of irrigation in the Salt River Valley, additional development, which includes the construction of the Mormon Flat Dam and the raising of the spillways of the Roosevelt Dam, will increase the water storage capacity nearly 400,000 acre feet, bringing under water 8,000 additional acres of the very finest farm lands.

The Salt River Valley lies just south of the central portion of Arizona, not far from the capitol at Phoenix, and promises to be one of the most productive districts in the West, with excellent opportunities for small farms.

In addition there will be developed a considerable area that can be irrigated in part with surplus water, and in part with pumped water. Hydro-electric power that will be available from the improvement work just noted will be available at low rates for operating these pumps.

This development work will cost \$1,800,000, and at a recent election the farmers of the Salt River Valley, who as land owners compose the Water Users Association of the project, voted to raise this amount by the sale of bonds.

The power available at the present time, returns an annual revenue of \$800,000. With the improvements planned there will be an increase of revenue to the



Fine highways prevail in the rich irrigation country in the Salt River Valley, Arizona.

farmers of nearly \$500,000 annually. The revenue from the power developed by this project will not only pay all costs of distributing the water through the canals to the land, but will also very nearly pay the annual assessments which are made to repay the U. S. Government for the cost of building the Roosevelt Dam and the canal system for distributing the water to the irrigated land under the Roosevelt project.

The Salt River Project has returned an annual crop revenue of \$16,000,000 for the past five years, exclusive of the revenue from live stock which for the past year was estimated at \$5,000,000.

The principal crops grown are alfalfa, cotton, grain, grain sorghums, fruits and vegetables. Dairy cattle lead in live stock importance, there being about 22,000 dairy cows in the valley. Creameries, cheese factories, condensed milk plants and ice cream plants handle the milk and cream produced. Thousands of range steers are fattened on the valley farms. Hogs are raised economically on alfalfa, skimmed milk and grain. Many sheep are also wintered in the valley and, after the lambing and shearing season, are driven back to the ranges in the northern part of the state. Poultry has increased about 30 per cent in numbers during the past

two years, and yet eggs are being shipped in from other states to supply the needs of Arizona.

The Salt River Valley section is a country which is ideally adapted to small farms and where the small farm is paying, and paying well. It is a place where one may make a home in the country and have the comforts and conveniences of city life. Three hundred miles of paved roads connect all parts of the valley with the towns. Electric power lines are being pushed out into the country districts and many farm homes now have electric current available for light and power. With the increase of power development, much more power will be available for farm homes, as well as a large revenue from the sale of current to mines and utilities.

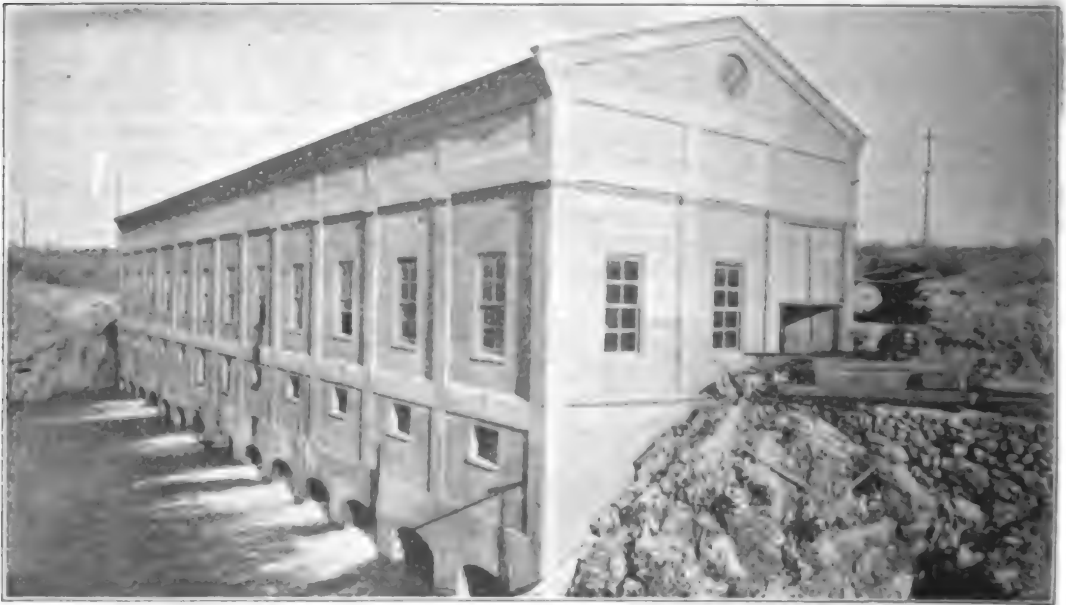
— J. W. B. SMITH

The Retort Courteous

THE up-country lawyer for the prosecution was cross-examining the old hard-boiled railroad engineer:

"Do you mean to stand up there and tell ME that you can take that spy glass and that painted stick, and measure up a man's farm?"

"Well," said the old fellow with a disgusted look, "What would you think I'd use, a quart cup?"



The large hydro-electric power house on the Salt River project, Arizona, which will develop electric current available for light and power in the adjacent country districts.

Feeding the Brute to Discover Its Habits

ARMCO
INGOT IRON
Resists Rust

THIS picture shows the testing yards where we continually feed metal to the great iron-eater—rust.

Snow and rain, cold and heat—all the elements are given a chance to show their power of destruction on sheets of ARMCO Ingot Iron and other metals.

When the metal sheets have been there for months, the chemists and metallurgists examine sections under a powerful microscope. To an outsider, the difference in effect on ARMCO Ingot Iron and other irons would be a revelation.

The survival of ARMCO Ingot Iron is due to its purity. Foreign matter that invites rust has been eliminated during the special process of manufacture.

These testing yards and our extensive research laboratories are indications of the great, unceasing care taken to maintain the purity of ARMCO Ingot Iron. If you are a user of iron products where rust-resistance is required, write to us.

Snow-covered Testing Yards at ARMCO Plant



This triangular trademark on culverts, flumes, siphons, tanks, road signs, roofing, etc., is your assurance of quality and unequalled rust-resistance.

The American Rolling Mill Co.
MIDDLETOWN, OHIO



Why ARMCO CULVERTS Can be Dated



AT the upstream end of every Armco Culvert is placed the Armco Date Tag—your guarantee of genuine Armco Ingot Iron—our pledge of confidence.

Here are the reasons why *Armco* Culverts can be tagged:

Uniformly Durable: Armco Ingot Iron is not only the purest commercial iron; it is the most uniform in its purity.

The Armco Culvert you buy today is of exactly the same material used in the thousands of Armco Veterans that have made this culvert the standard for durability and economy.

Tested Everywhere: Installed in every State, in Canada and many foreign countries, Armco Culverts have been tested for longer periods and under more widely varying conditions of service than any other metal culvert.

Insist on the ARMCO Tag



The HIGHWAY MAGAZINE

SEPTEMBER
1923

Read about
"The Oldest Road
in America"
(See Page 3)

**Write to the nearest manufacturers for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equip. Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Calgary, Vancouver, Vernon

The HIGHWAY MAGAZINE

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VOL. XIV

SEPTEMBER, 1923

No. 8

WHICH WAS THE FIRST AUTOMOBILE?

Top right: Miss Fay L. Cusick claims that this is the oldest gas driven car in the world. The motor was built in 1889 and the car was built in Milwaukee in 1890.

Center: Another claimant for the honor of being the first automobile built in America. Photograph shows inventor and builder, Mr. Elwood Haynes, standing on the exact spot



where more than a quarter of a century ago the car shown started on its first run. At the left is seen the monument dedicated to Mr. Haynes, which was erected by the Indiana Historical Commission and the Hoosier State Automobile Association at Kokomo, Ind.

At the right is shown another ancient gasoline automobile, built by George Selden and patented by him November 5, 1895. This car is now in the National Museum, Washington, D. C.





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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Smooth Railroad Crossing Found

THE problem of designing a smooth-riding, enduring crossing where a cement concrete highway crosses a railroad at grade, which has vexed highway engineers and contractors, has been satisfactorily settled by the Arizona State Highway Department.

The crossing design as employed on the Tucson-Nogales State Highway embraces steel railroad rails placed parallel to the railroad track, both between the tracks and on the outside for approximately 18 inches.

The rails are placed ball up and the interstices are filled with concrete. The result is a crossing that is smooth at any speed vehicles over it may assume.

Finance

LITTLE Tommy had unfortunately picked up a few service ditties his father had absent-mindedly carolled about the house until he had been out of the army long enough to become civilized again. One of them was the unforgettable "Mademoiselle from Armentieres."

"I know a pretty French song," he confided to a lady visitor at his home.

"How sweet!" she ejaculated. "Sing it and I'll give you a penny."

"No chance," retorted Tommy scornfully. "I can get a nickel any time for not singin' it."

The Road Clearing

By SOPHIE TUNNELL

OURS was a sleepy road that slipped past the town
Winding by the furrowed ground and orchards gay
Covered with petals and leaves drifting down
From the trees and tangled briars by the way.

Sweet was the song of the thrush thro the day,
Sweetly rose the song of meadow lark at dusk,
Fair were the pools where the dappled sunbeams lay,
Faintly came the scent of fern and mint and musk.

Men came. Their axes were sharpened and bright;
Swiftly fell the maple, hazel brush and rose;
Sad is the song of the lark in the night,
Fainter comes the scent of fern the west wind blows.

Proud now the paved road that sweeps from the town,
Gone its wistful beauty that we loved so long;
Fair in our hearts yet, it winds up and down
Dusty little road of trembling leaf and song.

Earth Road Maintenance in Iowa

CONSTRUCTION and maintenance of earth roads on the three systems, primary, county and township in Iowa during 1922 cost \$14,031,606. Of this \$6,838,535 was for maintenance and \$7,197,071 for construction. Maintenance on primary roads cost \$1,276,375 on 4,723 miles which were under the patrol system. The average cost of maintenance of earth roads on the primary system was \$270 per mile. Maintenance on 9,408 miles of county roads which were under constant maintenance cost \$1,790,937. The average on this was \$190 per mile. Maintenance on the 86,595 miles of township roads cost \$4,771,223 or an average of \$55 per mile.

Paving the Oldest Road in America

By B. F. CLARK

Special Correspondent for The Highway Magazine

More than 300 years ago the Spaniards were freighting supplies into New Mexico. Their first highway, now being paved, is part of the National Old Trails Road on the southern route to California.

DON JUAN ONATE, a Spaniard who lived in New Spain in the fifteenth century, was the first man to blaze out a road in America. Long before the Pilgrim Fathers landed at Plymouth Rock, Onate had marked out this road which started at Santa Barbara, now Jiminez, Mexico, and ended in the vicinity of what is now Santa Fe, New Mexico.

This territory had been claimed by the King of Spain, in 1598, and in 1606 Santa Fe was founded as the Capital of New Spain. This route was used later as a highway over which goods were freighted from the Gulf of Mexico, via Vera Cruz, Mexico, City of Mexico and Santa Barbara, until the Santa Fe trail was opened up between Kansas City, Mo., and Santa Fe, in 1822. This old road was then known as the "Camino Real" and it traversed the Rio Grande valley from the Gulf to Santa Fe.

The Rio Grande flows through a very



How the oldest road in America looks today. This paved highway marks the trail used by the Spaniards about the year 1600.

narrow and flat valley with foot-hills and mountains on either side, and during the flood seasons when the snow is melting on the mountains the water table level is very near the surface of the ground in many localities. Because of these conditions the old road wound around the foot-hills in many places. Later, when the country became settled and sectionized, the road had to be laid out on section lines. Going straight across the hills in this country is an impossibility, so the road was doomed, in most places, to follow the marshy valley. In the language of the old settlers this road "was something fierce" for many years.

Although the road had been improved in the worst places with a gravel surface, the state highway department of New Mexico found that the maintenance cost of the road was rapidly increasing, and it was evident that the increasing traffic would soon necessitate a hard surfaced road. A federal aid project agreement was drawn and a contract was let to the Lee Moore Contracting Company, of El Paso, Texas, for a concrete road 16 feet in width, from Albuquerque to the north county line. This section is a part of State Highway No. 1, and of the trans-continental National Old Trails road. At the present time the New Mexico Auto



Old mission bells used as sign posts along "El Camino Real"—the King's Highway.



Drainage is a problem on the oldest road in America. At the left can be seen seepage water from irrigation projects, standing by the roadside.

Club is marking all of the state highways so they may be followed from one city to another by numbers alone.

All of the land on either side of this road is irrigated, and in order to make room for the elevated irrigation ditches to pass beneath the highway, and because of the marshy, sandy nature of the terrain, the roadbed for the pavement had to be built up from two to three feet above the surface of the ground. On top of this subgrade was spread an eight-inch layer of gravel, the gravel being rolled with a heavy steam roller before the concrete was placed.

This bed of gravel was only used in places where the ground water level was within two feet of the surface of the ground. Where the water level was below three feet the gravel layer was not deemed necessary.

Two-inch mesh reinforcing was placed two inches below the surface of the concrete, wherever the subgrade seemed to require additional strength, and this wire mesh was also used over the arches of irrigation and drainage ditches.

Scattered along one side of this road are many gravel and sand deposits, which supplied clean sand and gravel for the building of the road. Wells drilled to the depth of twenty feet anywhere along the job, provided water for the mixing of the concrete.

The concrete on this road has an average thickness of six and one-third inches. Every thirty feet there is an elastic expansion joint one-half inch wide, and the thickness of the concrete.

Three-foot shoulders were built along the slab and the sides then continued on a one-third slope. The pavement was finished by the roller and belt method, and then was covered at once with a wet canvas supported upon frames. This canvas was kept wet until the finished pavement was covered with earth. The climate is usually very dry, and there is considerable wind, but the above method proved successful in keeping the concrete from cracking and hair-checking while it was curing. The paving was kept covered with earth for seven days and the road was not used for fourteen days after the paving was completed.

During the last five years, traffic on the Old Trails Road both north and south of Albuquerque, New Mexico, has increased from 50 motor vehicles a day to about 600. Many of the quaint and historic Pueblos lie along this old trail, and not far to the west of it, is the cliff dweller region of New Mexico. Due to this fact, and also, that the old road runs through millions of acres of Forest Reserves, motor traffic is bound to increase.

The twenty miles of paved road to north and south of Albuquerque has been a boon both to the city and county. The only agricultural land in the county lies along the Rio Grande River valley, and as this road runs up the valley it has become of great benefit to the farmers and fruit growers.

A contract for seven more miles of paved road is now under construction south of the city, and will extend the pavement on the Old Trails road nearly across Bernalillo County. A bill has just passed the State Legislature, appropriating several millions of dollars for road work in the state.

According to the highway laws of New Mexico all moneys derived from the tax levies on auto license fees, gasoline tax, are reapportioned for the use of the several counties of the state in road improvement. And the federal aid funds are appropriated in amounts equalizing the amount raised by each county. This old highway, running as it does through the most fertile region of the state, and coming more and more into use as a southern route to California, will, in a few years, be one of the finest roads in the state of New Mexico, as well as the oldest in America.

Good Roads and Their Effect on the Farm Woman's Life

By MARY E. WARD

The author of the following article, which is the second in a series of interesting studies on good roads in their relation to the farmer, is particularly well qualified to write on the subject of good roads as they affect the woman of the farm. She is the mother of three children and is also a grandmother. As a highway contractor and owner of a gravel pit, Mrs. Ward has taken an active part in many good roads campaigns.

OF a variety of interests in my life, the paramount one outside of home and family, has been good roads. A campaign for them has always, and will always find in me a staunch supporter.

As a farm woman who has spent most of her life in the country and in a vicinity where, in certain times of the year, the roads were bottomless, I know the inconveniences, the handicaps and miseries, that come from being surrounded by muddy, neglected roads.

As a worker in numerous good roads campaigns, as a gravel pit owner and contractor, I have seen the pleasure that has come to farm women through the building of good roads. I have seen their vision of life widened, their advantages increased, and their home and family



Mrs. Mary E. Ward

relations bettered, as they were given added contacts with the outside world, through these good roads. To the individual farm woman, good roads have brought the opportunity of service to groups outside of her immediate family and are today contributing to her economic independence.

In my own life, two factors have contributed to my adoption of the good roads problem as my own. Early, I determined that I should not be handicapped by being forced to remain at home as my mother had been, because of impassable roads. An inheritance of a gravel pit gave me the opportunity to become a good roads worker as well as an enthusiast.

This pit has many times made it possible for me to donate gravel for the public needs in the community. I am



These two photographs show the condition of the highway leading to the Ward farm before and after Mrs. Ward donated the gravel for surfacing, and helped in the repair of the road.

ready today to donate my share on any of the main roads to be graveled which are near our pit. I have donated the entire amount of gravel used on the one and one-half miles of road past our farm in LaSalle County, Illinois, which is one mile west of Triumph, Illinois, and 80 miles south of Chicago. This farm, known as "Westgate," was bought from the government of the United States during the administration of James Van Buren, by my grandfather. The gravel pit is located on the farm area which was originally purchased.

In the good roads campaigns, whenever and wherever possible, I preached the doctrine of better roads, I visited my neighbors, pointing out to them that we were missing advantages, financial, social and educational, by being forced to remain at home when rains or snows or thaws made traveling an unpleasant undertaking. I campaigned for these improvements in season and out of season, and with the assistance of our road commissioners and interested neighbors they were put under way.

To me good roads mean that the farm woman will be brought nearer to the advantages that the woman in the city has. With roads passable at all times of the year, the library, the lecture hall, the museum and the election booth are brought nearer home, and really accessible.

If country women are to take part in the making of the laws of the country, and do so intelligently, they must have



There is no trouble keeping the boys and girls on this farm, which is in the center of a district famed for its good highways.



The kitchen of a typical farm house a few years ago. Poor roads were the cause of isolation and the primitive mode of living shown above.

good roads in order that they may keep in touch with outside activities. A more intimate knowledge of existing conditions, brought through contact with outside sources, comes easiest when traveling is easy.

It is a good investment to build good roads. It is a good investment for the farmer who wants to market products at all times of the year; it is a good investment for the parents who want educational advantages for their children; and it is a good investment for the man who would avoid having his wife develop into a "telephone gossip." Women, as well as men, have a natural longing for news, whether it be of the world, or of their own particular neighborhood. If they cannot get to their neighbors, to the club, or to church, the misuse or abuse of the telephone will probably result. I have told many a man who complained that gossiping women were using his telephone line, that if he would help boost our good roads campaign he would relieve himself of the telephone nuisance.

To me good roads have five definite ends—those of health, of convenience, of culture, of service to the country, and of furnishing a means to economic independence. With good roads it is easier

for the country doctor to make his calls and in cases of accidents it is doubly important that there should be good roads so there will be no delay from minor matters, such as a bad road which makes it impossible for the physician to use his car. In the past many cases have been observed where, if the roads had been improved, a life might have been saved could medical attention have arrived a short time sooner. And often these accidents do happen. Farm implements are complicated and dangerous to investigate when the would-be-mechanic is somewhat ignorant of his machine, in the bargain.

Convenience is, of course, next important on the list. In itself many farmers would overlook the mere fact of convenience but in many instances the farm woman will place double the importance on convenience that her husband will.

Culture is, in a progressive sense, easily dispensed with and forgotten when it is difficult to find a way of transportation between the farm and town. But with easy accessibility of mails and of attending the best offerings and seeing the best talents which the near-by towns furnish, it affords at least a stimulus to culture and in this—good roads have a definite place. A half hour ride in the automobile on good roads is certainly no impediment to seeing the best things in town when a ride of an hour and a half in a buggy over disagreeable, and at times, impassable roads certainly would be. Many families on farms are distinctly movie fans and a short ride in their car to the nearest movie is a step in the cultural movement.

Any medium which contributes to the

added intelligence and interest of more people in the welfare of the country certainly performs a worthwhile task. In such a capacity good roads act in giving added service to the country of many more interested people.

Good roads mean greater economic independence, in that any field of work is strengthened necessarily when they become less independent on other industrial groups. For the above reasons and many other minor ones it is certainly desirable and a progression to push the good roads movement until every farm home has easy accessibility to the nearest center of trade, society, and education.

Automobiles have been greatly instrumental in our good roads fight I believe. Motorists judge the progressiveness of a community by the manner in which the roads are kept in repair. And with motoring becoming yearly more popular, the majority judgment which is passed on a slovenly road, thus labels the locality as one backward in progress and interest for the public welfare.

I have always believed that the farmer and his family were entitled to the same advantages as the city family. This remains out of the question until we have good roads suitable for the automobile at all times of the year. If country women are to help make our laws and do so intelligently, they must have good roads in order to keep in touch with outside activities.

The day has passed when women will remain in a narrow rut unless they are actually lazy and refuse to take advantage of the opportunities. Our government owes good roads to the women, but more than all to the children of today.



A section of the famous Lincoln Highway. Paved roads mean greater opportunities in the social and civic life of the community for the farm woman of today.

President Harding Dedicates the Zero Milestone

The dependence of the United States on the development of good roads is portrayed in the President's Address at the dedication of the Zero Milestone in Washington.

"MY countrymen, in the old Roman forum there was erected in the days of Rome's greatness a golden milestone. From it was measured and marked the system of highways which gridironed the Roman world and bound the uttermost provinces to the heart and center of the empire.

"We are dedicating here another golden milestone, to which we and those after us will relate the wide-ranging units of the highway system of this country. From the golden zero stone of the Roman highway system the soldiers, the adventurers, the administrators and later the missionaries of Rome went out to carry the institutions and the civilization of the imperial state to their expanding world. The Romans were the highway builders of the ancient world, and we shall find inspiration on this occasion in the thought of how greatly their highways influenced the course of all history since their time.

"Our country has been more dependent upon the development of internal highways than any other in all history, because our vast continental area is so ill supplied with those arms of the sea which have always kept the countries of western Europe in close touch with that great universal and common highroad, the open ocean. To us, coming late in the drama of human development, it was particularly necessary that wonders of highway construction should be accomplished in an almost inconceivably short time. On the whole, we have made a wonderful progress, as is attested by the fact that our continent possesses approximately half of the world's whole mileage of railroads. But in the matter of rural roads, tributary to these, we have until very recent years made a far less impressive advance. Within two decades, however, marking the beginning of the motor age, our advance in this respect has been phenomenal.

"It is appropriate, too, that our golden milestone has been placed here in the



President Harding making his address of acceptance of the Zero Milestone Monument, unveiled and dedicated recently, before an audience of several thousand persons in Washington, D. C.

National Capital, the spiritual and institutional center of the nation. From it will diverge, to it will converge, the ceaseless tides whose movement will always keep our wide-flung population in that close intimacy of thought and interest and aim which is so necessary to the maintenance of unity and nationality.

"It is, therefore, apparent that this ceremony of today is truly significant in connection with the evolution of a national system of highways. In accepting the gift of this zero milestone to the nation, I wish to thank the Lee Highway Association for the contribution which it plans to the security, unity, development and welfare of our nation. We may fittingly dedicate the zero milestone to its purpose in the hope and trust that it will remain here through the generations and centuries, while the republic endures, as the greatest institutional blessing that Providence has given to any people."

Parallel Drains on Public Highways

A Consideration of Practice in the Installation of the Side Road Culvert

CULVERTS have always been a rather neglected factor in the engineering of roadways. As a result, even those culverts under our main roads are frequently insufficient both in capacity and number. A still greater inadequacy, of course, attends the culverts placed in the lateral ditches under small roads or farm entrances, which only too frequently are "homeless orphans" for which no one seems responsible.

In many instances, it is the practice to leave all details of the parallel drain to the property owner, whose uses are served by the presence of the branch road. Where this practice obtains, the property owner usually selects the cheaper type without regard to serviceability. As a result, three classes of inadequacy in the driveway culvert installation—if there be one at all—have frequently been observed—

Culvert may be too small.

Culvert may partially or completely fail, restricting flow.

Culvert may fail, leaving nothing more than a ditch as an approach to the highway.

Naturally an inadequate culvert causes water from surface drainage to pond in

the side ditches with consequent damage to the road. It is an axiom that good roads must be dry roads, and this applies to the foundation, as well as the surface. Deep seepage from impounded water in lateral drains causes uneven settling, which results in broken or uneven road surfaces and large expenditure for maintenance.

When the culvert is not installed, or when a shallow installation has failed, leaving a poor approach, heavy traffic on the side road climbs the shoulder of the highway with great damage, as shown by the photograph on page eleven.

Neglect of the parallel drain in the construction of the trunk highway is most often the result of a policy of keeping down the apparent cost of the road by leaving the small side road or farm entrance to the care of the property owners.

Roads are being constructed with great rapidity; in almost every case there is need for many times the mileage that can be built with existing funds, and every possible means is used of keeping such funds strictly to the business of building trunk highways.

In many instances, recommendations will be made to the owner of the property, but often he dodges his responsibility. He may be an absentee landlord, anxious



This is a heavy monolithic culvert and is a striking example of the waste that frequently results by using non-removable culverts for driveway service. The driveway has been fenced in and the culvert is a loss.

The Scenic Roads of Vancouver Island

By DONALD A. FRASER

Special Correspondent for The Highway Magazine

PROBABLY no part of the west has been a more popular touring ground for the automobilist this summer and last, than Vancouver Island. This huge breakwater that protects the southern half of British Columbia's coast is two hundred and eighty-five miles long. Roads extend for only one hundred and eighty miles along its eastern side, and these are all connected with, or form branches of, one main artery known as the Island Highway.

This extends from the City of Victoria on the southeast corner of the island northwards to Campbell River, passing through Duncan, Ladysmith, Nanaimo, Courtenay, and other points, with one branch leading to the west coast of the island at Port Alberni. Where this highway passes along the shoulder of the heights known as Malahat Mountain, it forms the famous Malahat Drive, commanding splendid views of the Saanich Inlet, and the Gulf of Georgia.

The principal charm of the roads of Vancouver Island lies in the fact that they traverse such varied scenes. The park-like oak glades that surround Victoria, give place to dense forests of Douglas Fir, Western Cedar, or Sitka Spruce, farther North. Then the road will emerge from some rocky, stream-threaded gorge to skirt high cliffs over-



Touring among the rocks and Douglas Firs in the shadow of Malahat Mountain on the famous Malahat Drive, Vancouver Island.

looking vast panoramas of island-dotted stretches of azure-tinted sea. The lovely hill-encircled lakes of the island are not the least attractive feature either. Sproat, Great Central, and Cameron lakes are some of the most popular. The first-named is the one that has captivated Cornelius J. Vanderbilt, Jr., so much that he has bought an island in it, and built a summer bungalow there. Alpine scenery rivalling anything that Switzerland or the Rockies can show, in charm, if not in extent, is found in regions around Strathcona Park, near the center of the island.

The island roads are mainly of gravel or macadam, kept in good repair by the Government of the Municipalities. Long stretches near the more important places are asphalt or cement-paved.

During the summer of 1922 more autos visited Vancouver Island and toured its highways than in any previous season. Cars from all over Canada and the United States were among the number and from the expressions of pleasure given voice to by their occupants, there are bound to be even more this year.



One of the many beautiful views which greet the motorist on the Malahat Drive, Vancouver Island. Photo shows a part of Saanich Inlet.



Irrigation and Drainage

Building a Great Dam With Water

The completion of the Henshaw earth-dam, impounding 55 billion gallons of water, and constructed at an approximate cost of \$900,000, brings 50,000 acres of land under irrigation in San Diego County, California.

A NOVELTY in engineering is the so-called earth-filled dam built by the Santa Fe Railroad and William G. Henshaw to impound waters of the San Luis Rey River in San Diego County, Cal. The filling has been done by hydraulic means and with fine, impervious clay. This type of dam was determined upon after it was found that solid bedrock did not exist as a base for a masonry dam.

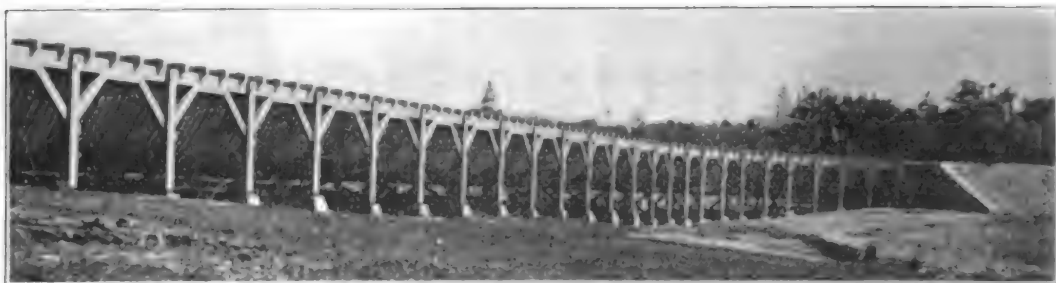
Ordinarily the building of an earth dam does not involve any spectacular features. It is merely a question of moving so much earth and it is usually done in the most

simple and economical manner possible. It was different, however, with the construction of the big earth dam on the historic Warner ranch in the northern part of San Diego County. This was a rush job. Work was started June 1, 1922, and it was desired to have it completed by the first of the present year in order that it might not be subject to damage by early floods and would impound as much water as possible during the rainy season.

To accomplish this it was necessary that construction should be prosecuted 24 hours a day to move and place the



The above photograph shows the top of the Henshaw earth-dam, which provides a reservoir of 55,000,000,000 gallon capacity, capable of irrigating 50,000 acres of land in San Diego County.



A huge Armco ingot iron flume carrying tons of water on a western irrigation project.

450,000 cu. yds. of material required for the dam and to make the spillway.

The Henshaw Dam as it will be known, is located on the San Luis Rey River about 51 miles above its mouth at Ocean-side, and about 65 miles northeast of San Diego. The site is a narrow gorge known as the San Luis Rey canyon where three mountain streams, known as Carrizo, Buena Vista and San Luis Rey, merge into one, which courses through a series of small fertile valleys to the ocean. The dam site was first surveyed 30 years ago, but borings failed to disclose bedrock foundation for a masonry dam.

IMPOUNDING CAPACITY, 200,000 ACRE FEET

The dam is 117 ft. high above the stream bed and about 140 ft. above bed rock and 600 ft. long on the top. At the base it is 58 ft. thick, sloping to 20 ft. in width at the top. The entire crest line of the dam, including auxiliaries, is about 1600 ft. in length.

At its present height the dam will impound 164,000 acre feet. Later the impounding capacity may be increased to 200,000 acre feet by raising the dam 7 ft. The basin for the reservoir was at one time the bed of a natural lake. When the reservoir is filled the water will have a mean depth of from 40 to 50 ft. and will cover about 7,000 acres extending up stream to within two or three miles of Warner's Hot Springs.

The spillway is 500 ft. in length and cut through solid rock at the west end of the main dam. The floor of the spillway is 10 ft. below the crest of the dam and it is estimated that the spillway will carry a volume of water in excess of the maximum recorded flow in flood of the San Luis Rey River.

To protect the down stream face of the dam the slope is covered with earth rock rip-rap and at the toe a rock mattress 10 ft.

thick and 100 ft. wide has been constructed to prevent damage by back-wash from the spillway.

The main dam has an hydraulic fill core built up between two banks of dry earth, the core comprising about half the total thickness of the structure. Material for the dry fill was obtained by cutting away a hill on the west side of the canyon for the spillway. This made a short haul, approximately 500 ft. but on a steep slope. Excavation was made by four steam shovels and the earth was hauled in dump wagons by mule teams. Part of the haul was up a stiff grade and a small caterpillar tractor and electric hoists were used to lighten the burden of the mules up the slope. No attempt was made to pack the dry earth, the weight of the wagons and tractors and wetting of the earth in layers compacting it sufficiently.

PROBLEM OF HANDLING SUPPLIES

Material for the hydraulic fill was sluiced from the bed of the basin about a half mile up stream from the dam. This material had a 30 per cent content of clay.

Owing to the isolated location of the dam site, at an elevation of 2,724 ft., bringing in of materials and supplies was an arduous task. The nearest railway station is Temecula, from which point the 6,000 barrels of cement used were hauled 38 miles. Machinery and other supplies were hauled a distance of approximately 65 miles from San Diego or Escondido. Both trucks and teams were used for hauling. An average of about 400 men were employed and 300 mules were used on the job. A model camp was established for the men with a community dining hall, pool hall, guest house and public school for 25 camp children where the best food obtainable was served.

The cost of the dam was about \$900,000.

How the Irrigation District Functions

By WELLS A. HUTCHINS

*Assistant Irrigation Economist, United States Department of Agriculture
The following discussion of how irrigation districts operate, with particular reference to California, gives a brief resume of what the federal government has accomplished in cooperation with the state and the University of California.*

THE United States Department of Agriculture has recently completed a study of the operation and financing of irrigation districts throughout the West and will probably issue a bulletin on the subject in the near future. The irrigation district is well known in California, for it originated in its present form in that state and has come to be more popular there than any other form of irrigation organization. Necessarily the district is of greater public interest in the agricultural sections of the state, such as San Joaquin and Sacramento Valleys, than in the cities. On the other hand, irrigation construction is usually financed through the sale of bonds to bond houses and through them to the public, so that more and more as bond issues are disposed of, the irrigation district is coming to be known among investors of both large and small means.

An irrigation district is similar in some respects to a municipal water district, except that its purpose is to provide water for irrigation instead of for municipal purposes. It is a community enter-



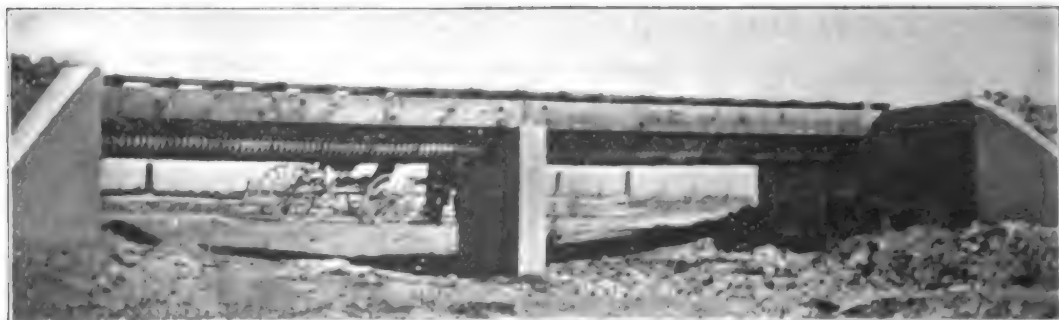
Installing an Armco ingot iron flume near Manteca on the South San Joaquin Irrigation District.

prise, owned, managed and operated by the irrigators themselves. Organization is proposed by means of a petition to the board of county supervisors. The state engineer then makes an investigation of the feasibility of the undertaking and adequacy of the proposed water supply. If the report is favorable an election is held upon the question of organization. An adverse report by the state engineer, however, prevents the calling of an election unless three-fourths of the landowners in the proposed district petition the supervisors to go ahead in spite of the unfavorable state report. After the district has been formally organized, plans are prepared for construction of the irrigation system and are submitted for the approval of the state bond certification commission, after which the district may proceed to offer its bonds for sale in order to provide money for building the necessary works.

The district is managed by a board of directors elected by the people. An assessor, a collector, and a treasurer are also elected, but all other employees are appointed by the directors. Money is



View of an Armco flume installed by the Turlock Irrigation District in 1917.



A large Armco ingot iron corrugated flume installed by the Sacramento Valley Irrigation Company in the rich, irrigated Sacramento Valley District.

raised for operating expenses and for paying the interest and principal of bonds by means of assessments levied upon land and collected by the district in the same manner as collections of taxes by the county. In fact, in most states which have irrigation district laws, the district assessments are collected by the county tax collectors at the same time as state and county collections, California being one of only three states which provide complete district machinery for assessment purposes.

The original irrigation district law of California, upon which the district laws of the other Western states are based, was passed in 1887. This law, known as the Wright Act, was sponsored by C. C. Wright of Modesto, who is said to have been sent to the legislature to procure the passage of a law which would afford relief to communities in need of irrigation but unable to get together because of the opposition of powerful landowners. Grain farming had begun to be unprofitable and it was becoming evident to the holders of small acreages that if they were to continue in the farming business they must obtain water. The large landowners, however, were opposed to a change and refused to join in a community effort to obtain water. The situation was further complicated by the decision just rendered in the now celebrated case of *Lux v. Haggin*, which established the rule of riparian rights in California. So it seemed to the farmers in some of these communities in San Joaquin Valley that their only hope of farming under irrigation lay in an organization by which the minority could be forced to contribute in an equitable degree to the cost of irrigation, and the demand for some such

organization resulted in the passage of the Wright Act.

The formation of irrigation districts began immediately. Within three months after the statute was enacted the Turlock Irrigation District had completed organization, followed shortly by Modesto District. Changes have been made in the law to prevent the district from being used for purposes of exploitation and to strengthen the security for district bonds, with very beneficial results. The district is coming more and more to be considered the accepted form of organization for building irrigation works.

Other states than California have had their irrigation district history. All of 17 westernmost states have passed district laws and most of them have districts in operation at the present time. Districts have developed extensively in the Pacific Coast States and in Idaho, Montana, Colorado, and Nebraska, and on a smaller scale in several other states, with California considerably in the lead in number of districts, acreage, and extent and cost of construction.

The results of the department's study of irrigation districts show that the successful districts have been mainly those formed for purchase and operation of constructed systems which were going concerns, or for extensions, improvements, or supplemental water supplies, or for building new irrigation systems only in those sections already productive under dry farming methods or where development has followed rapidly. As a result of greater recognition in recent years of the factors necessary for success, coupled with a more discriminating bond market, recent development by districts has tended to be generally conservative.

ARMCO INGOT IRON

TRADE MARK
FOR ENAMELED PRODUCTS



The Beauty of Fine Porcelain with the Strength of Iron

Look for this Blue and Gold Armco Label on Washing Machines, Stoves, Ranges, Refrigerators, Enamel Table Tops and other household & commercial utilities. It carries with it the assurance of the quality and solid worth of the sheet metal parts of articles that bear it.



A refrigerator of enameled "Armco" Ingot Iron has the sheer, beautiful gloss of fine porcelain. The surface is smooth and unbroken by "pin-holes," bubbles, or lumps.

This is due to the purity of the iron base. By special processes of manufacture, "Armco" Ingot Iron sheets are purified of foreign matter that is found in all iron ore and in the other metals used. Thus the tiny atoms of iron

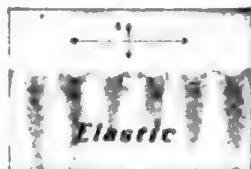
are closer together, the texture is uniform, and the enameling grips with the maximum adherence. There is no tendency of the enamel to split, crack, or flake.

When buying a refrigerator, a stove, a washing machine, or an enameled table top, ask the salesman if it is made from "Armco" Ingot Iron. Look for the blue and gold Armco triangle, which manufacturers are glad to place upon such products.

Write for Needed Information

The American Rolling Mill Company
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The A-B-C of Culvert Engineering



Corrugated Culverts give to stress in any direction.



Corrugated Culverts endure pounding and reversal of stress better than any other type.

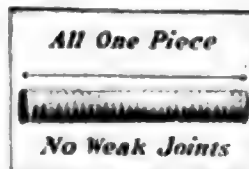


ARMCO Culverts have been proved uncrushable under a fill equal to diameter.

A Few culverts can have an adequate foundation. They are usually located in depressions filled high with silt. In most instances, it is totally impractical to dig deep enough to give any structure a bed-rock base in such a location.

B When foundations are at all adequate, they are usually the most expensive part of the installations—an expense far in excess of that required.

C There is but one type of Culvert that will endure without resting upon a solid base. The well made Corrugated Culvert resists the forces of shifting, heaving earth, settling, freezing and the weight and pound of traffic.



No Weak Joints



ARMCO Culverts do not absorb water. They do not "weather" like porous materials.



Settling and earth creepage leave the Corrugated Structure efficient and unharmful.

and—

The A-B-C of Corrugated Culverts

- A** The material of Corrugated Culverts must resist rust.
- B** Rust resistance requires high purity of the iron used, for two reasons—iron of high purity *resists rust of itself*, and it takes and holds more firmly a protecting coat of galvanizing.
- C** ARMCO Culverts are made of ARMCO Ingot Iron, the purest commercial iron produced, and of the highest **UNIFORM** purity. The ARMCO Culvert you buy tomorrow is made of exactly the same material that is found in ARMCO Veterans under the highways and railways of the world—the culverts that have made ARMCO the world's standard for durability and economy.

This Little Dot

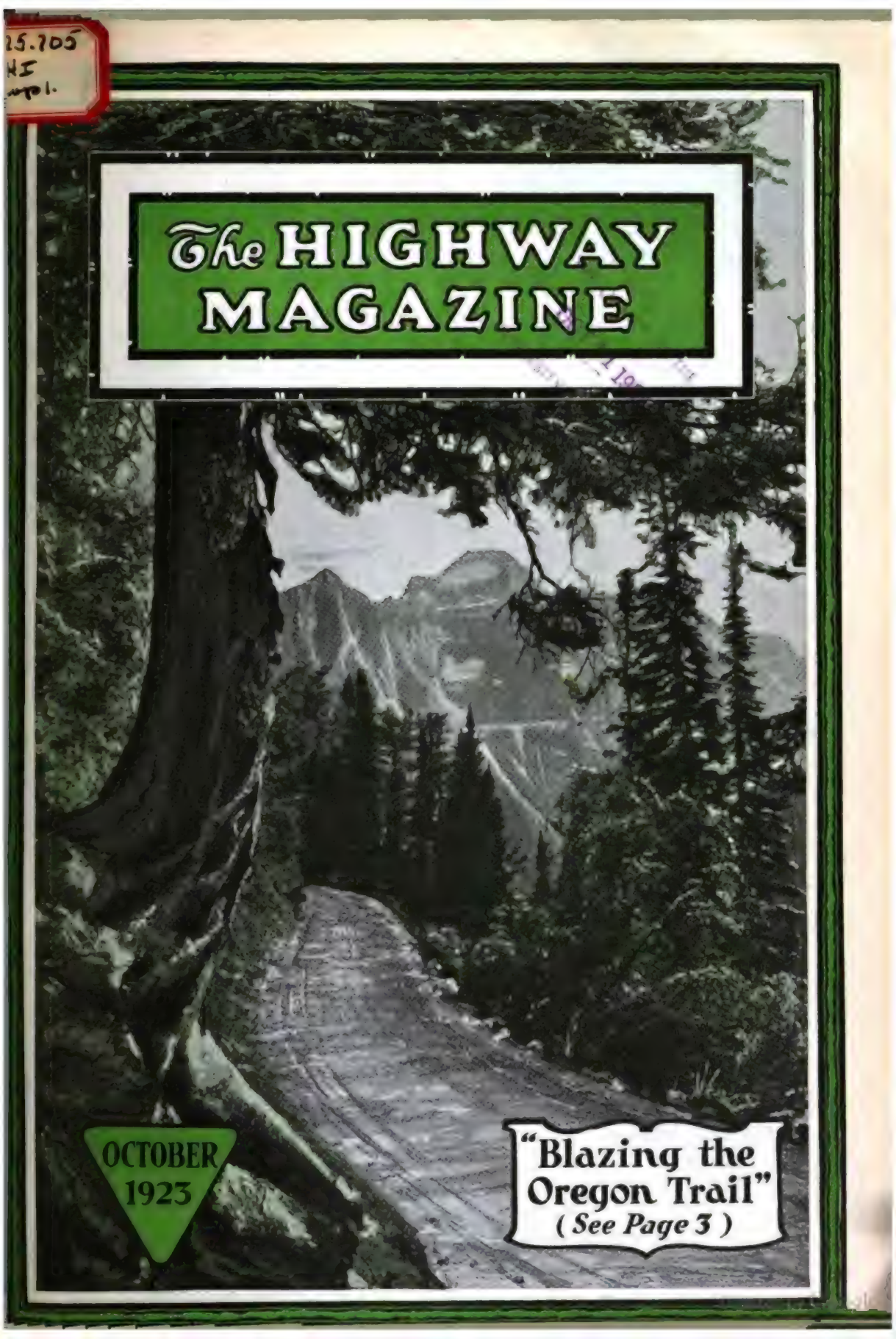
If this rectangle were a sheet of ARMCO INGOT Iron, the little dot would represent all the impurities. If the dot were the least bit larger, due to the addition of any other material, the result would not be ARMCO Ingot Iron. ARMCO has less than 1 part impurities to every 625 parts of pure ferrite—less than 1 ounce of impurities to every 39 pounds of pure iron.



Ingot Iron

ARMCO CULVERTS

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101.



The HIGHWAY MAGAZINE

OCTOBER
1923

"Blazing the
Oregon Trail"
(See Page 3)

**Write to the nearest manufacturers for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equip. Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The R. Hardesty Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Calgary, Vancouver, Vernon

The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIV

OCTOBER, 1923

No. 9



Salt Lake City "Cans" Good Roads

An economical method of getting rid of tin cans, ashes, and other rubbish, and also helping to build up wet spots in roads, is being successfully worked out in Salt Lake City, Utah. The material is hauled to the roads by motor truck, and from 18 in. to 3 ft. of the loose material is dumped on the road. This is leveled by means of a drag, and finally the entire mass is then rolled with a fifteen ton roller. This leaves the surface ready for screened gravel, which seems to pack more readily than when it is placed on a dirt surface. The accompanying photographs show the same stretch of road before and after the application of the gravel. In the photograph at the left, the swamp at the right of the picture was the former level of the road.



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FRANK E. KENNEDY.....Associate Editor
LOUIS A. GRAHAM, M.E.....Consulting Editor

Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

U. of Michigan Offers Fellowships in Highway Engineering and Highway Transport

TWO of the following Fellowships will be awarded not later than November 1, 1923, by the Board of Regents of the University of Michigan.

The Roy D. Chapin Fellowship in Highway Transport, which is offered to provide for the investigation of an approved subject relative to Highway Transport.

The Roy D. Chapin Fellowship in Highway Engineering, which is offered to provide for the investigation of an approved subject relative to hard surfaced roads and pavements.

Two Detroit Edison Fellowships in Highway Engineering which are offered to provide for the investigation of approved subjects relative to moderate cost country roads.

General Conditions: Each Fellowship pays the sum of \$250 with an allowance of \$50 for expenses. The holders of these Fellowships do not have to pay tuition fees. A Fellow must hold a Bachelor's Degree from a college of recognized standing. He must enroll as a graduate student in highway engineering or highway transport and as a candidate for the degree of Master of Science or Master of Science in Engineering. He must be in residence for one of

the following periods: First Semester (October to February); Winter Period (December to March); Second Semester (February to June). An application for a fellowship must include a concise statement of the candidate's educational training and engineering experience, and three references. Applications and requests for information pertaining to the twenty-five advanced courses in Highway Engineering and Highway Transport offered by the Graduate School should be sent to Professor Arthur H. Blanchard, Engineering Building, University of Michigan, Ann Arbor, Michigan.

Traffic Inspection Officers for Pennsylvania Highways

THE Pennsylvania State Highway Department will shortly place traffic officers on the highways. These men are provided for in the section of the Act of 1923 which amends Section 12 of the Act of 1919, governing motor traffic. This amendment authorizes the Secretary of Highways to employ such men as in his discretion are deemed necessary to the enforcement of the penal provisions of the motor laws. "Our traffic officers will pay particular attention to the overloading of trucks; speed of motor vehicles—and particularly the speed of trucks; the misuse of headlamps. No truck will be permitted to use Pennsylvania highways when it carries a load greater than that specified for the particular class in which it is registered. No truck will be permitted to travel faster than the rate specified for the class in which it is registered." The traffic inspection force is to be uniformed. The force will be mounted upon motorcycles. Certain members engaged in enforcing the law relating to truck weights will use motor cars in which their road scales will be carried.

Noise Wins

"What does the professor of Greek get?"

"Oh, about \$3,000 a year."

"And the football coach?"

"About \$12,000 a year."

"Quite a discrepancy."

"Well, did you ever hear 40,000 people cheering a Greek recitation?"

Blazing the Oregon Trail

By NELLIE BARNARD PARKER

In the following article the writer has presented a striking and vivid picture of the contrast in transportation methods and highway construction that featured the blazing of the Oregon Trail 80 years ago, with the recent dedication of the completed highway.

THE highways of the country are something more than a commercial asset to the state through which they run.

They are sometimes the symbols of visions, hardships and achievements; and the Old Oregon Trail is one of the greatest examples of that symbolism.

In October, 1810, just 113 years ago this month, Wilson Price Hunt, and a party of adventurous men left St. Louis, Missouri, with the end in view of establishing fur trading posts in the Oregon Country, a land known to abound in fur-bearing animals.

The story of this expedition is a long tale of tragedies, extreme suffering, starvation, Indian attacks, and every handicap possible in a wild country. After traveling a distance of 3,500 miles from St. Louis, Mo., to Astoria, Oregon, they completed their trip on the 15th of February, 1812. When it is considered that the actual distance between these two points is close to 2,000 miles, one can guess at the number of times they were lost or compelled to detour

because of mountains, streams and hostile Indians.

The men comprising this expedition were the men who blazed the original Old Oregon Trail from Fort Hull, near what is now Pocatello, Idaho.

In 1843 over 1,000 men and women left the comparative comforts and luxuries of an established country and followed into the great west; this time, however, over a shorter route which had been marked by some of the returning members of the Hunt party who had carried back the news of that expedition.

The outstanding feature of this great migration was that the first wagon train had been brought into a land of unsurpassed ruggedness, treacherous rivers, miles and miles of sand and alkali, and across trackless country that had never before known the imprint of a vehicle wheel of any description.

The success of this adventure caused 300,000 other plucky souls with a vision, to break home ties in the middle west and start out on the long journey to "The Oregon Country."



Above, the parade of ox-drawn prairie schooners coming over the top of the Blue Mountains exactly as it did in 1843, when the first wagon train entered Oregon Country. Below, left, the late President Harding riding in the rear seat of the old Concord coach at the "Top o' Blue Mountain Pageant," July 3rd. Right, a typical emigrant train scene during the Old Oregon Trail pageant.



A section of the Old Oregon Trail near La Grande, Oregon, "a broad, smooth highway, flung like a ribbon of satin across the country."

It is not the purpose of this article to tell of the tragedies of that trip but merely to tell of the origin of the Old Oregon Trail which leads the tourist of today through a fertile expanse of wheat fields, orchards and fruit lands, grazing country for thousands of cattle, unexcelled mountain scenery, the vast rolling hills bordering the Snake River, the wonderland of the Columbia River Highway, and on to the sea.

No highway stretches in such an unbroken thread of perfection, and through such varied and beautiful scenery as the Old Oregon Trail from Ontario, Idaho, to Seaside, Oregon.

But along this highway, and stretching back to the Missouri River, are thousands of graves of those who fell while helping to blaze a trail to the west. More than 5,000 people died of the cholera on that trip, and many more of exposure, thirst, starvation, Indian attacks and—heartaches!

It is right and fitting that the motorist of today should know and appreciate the undaunted perseverance of the pioneers who carved the first highway to the west out of the raw and rebellious land.

Beginning at the Idaho border, the new state highway travels through beautiful orchards to the Snake River and its great, bare, rolling hills. The highway itself is a marvelous piece of work, clinging as it does, to the high bluffs along the twisting river that is so very well named—"Snake River." Because of the perfection of the roadbed and the broad curves, the highway is not a dan-

gerous one for the careful driver; but with a sheer drop of many feet into the river on the one side and a perpendicular wall of rock on the other, it has its thrilling possibilities.

There are miles and miles of macadam road that allow a car to purr and hum along pleasantly. One stretch of road, not far from the Snake River, is sand finished for a distance of thirty miles, giving a pavement finish that stretches out across the desert land in two smooth tire treads that resemble endless twin strips of polished stand-stone.

It would be hard to find a more perfect ride than the trip from La Grande, Oregon, to the summit of the Blue Mountains. With the exception of a mile of road just out of La Grande which is under construction, the macadam surface of the highway is equal to pavement.

In places the mountain wall has been blasted away to gain a foot-hold for the highway on the steep slopes.

On the summit, where the late President Harding, a month before his fatal illness, unveiled a monument to the pioneers of Oregon, there was, at the time of the celebration on July 3 and 4, a stretch of six miles, remaining unfinished, because of constant rains. As the rains ceased, the work was resumed and now there is no break in the macadam perfection of the Old Oregon Trail Highway.

Emigrant Hill affords the motorist a wonderful view of the Umatilla Valley as it stretches out in a vast checker-board of wheat fields and farmsteads. The road is a splendid piece of highway engineering, turning and winding back and forth in an easy grade with good curves and other striking engineering features.

The Old Oregon Trail, as originally named, properly ends at Pendleton where it joins the Columbia River Highway, which is but another portion of the old original Oregon Trail. From Ontario to Pendleton, a distance of 193 miles, the highway is surfaced with broken stone or gravel with a little over ten miles of pavement.

Of an approximate cost amounting to \$3,500,000 at the completion of the highway, the state will have paid approximately \$2,000,000, the federal govern-



Making camp at the end of the day. How the immigrant train looked 80 years ago during the expedition which marked the blazing of the Oregon Trail across the sage brush land of the far West.

ment approximately \$500,000, and the counties through which the highway passes, the remaining \$1,000,000.

The pageant on top of the Blue Mountains, which the late President Harding attended, proved a complete success. More than 5,000 cars took part in the celebration, bringing people from Idaho, Washington, Wyoming and every section of Oregon.

Due to the perfection of the roads and the excellent work of the highway traffic officers, not a single accident occurred to mar the event. A speed of 25 miles an hour with no overtaking and passing of cars, was decided upon, but as the cars came in a steady procession, it seemed best to lower this to 15 miles nearer the summit. By demanding strict observance of the rules, the highway presented an orderly procession of cars.

The main feature of the pageant depicted the first wagon train as it slowly pulled over the crest of the hill 80 years ago; and as the onlookers watched the snail-like pace of the covered wagons drawn by oxen that had to be prodded into action, it seemed almost a miracle that the pioneers ever reached the land at all. To the motorist with his high powered car and his modern highway, this mode of travel, over rough, faintly-marked trails, must have seemed a page torn from the Spanish Inquisition, so slow and tortuous it appeared.

The site selected for the route of the parade was, as nearly as could be determined, the point where the emigrants of 1843 crossed the last great range that separated them from the land of their dreams and ambitions. It was only a quarter of a mile from where the new highway travels in its straight, smooth grandeur, close-packed with automobiles—that modern convenience which called it into being.

It is small wonder that the crowd of 30,000 people were awed at the spectacle. The contrast between the past and present was, perhaps, the most vivid comparison of its kind ever staged. To thousands of motorists who had traveled scores of miles in a few hours, over broad, smooth highways flung like ribbons of satin across the country, the spectacle of the jolting, rumbling, creaking wagons, creeping and swaying top-heavily down the wooded hillside, through the uneven meadow, and fording the streams to the accompaniment of shouts and cracks of whips, was a sight not soon forgotten, and brought home to everyone present the blessing of highways that have abolished most of the discomforts of overland travel.



One of the last official acts of the late President Harding, in the U. S. A., was the unveiling of the monument at the dedication of the Old Oregon Trail Highway, less than a month before his fatal illness.

Speeding Up Culvert Installation

Economy and speed are two factors that do not always go together in the installation of a drainage structure. A rush job may mean expense, particularly if the delay involves holding up the work of a grading machine and crew. A problem of this nature was successfully solved by the County Engineer of Clarke County, Iowa, in the following manner.

WHEN the Board of Supervisors of Clarke County started their road grading outfit last spring, they discovered that one of the culverts already in place on their first job would have to be replaced or repaired. The drainage structure in question was a corrugated culvert with concrete headwalls and a concrete spillway on the lower end. This spillway was broken down and the fill it was designed to protect was in bad shape, due to erosion.

Inasmuch as the grading outfit was already on the job, it was essential that whatever method of repair or replacement was employed must necessarily be one that would cause as little delay as possible.

The County Engineer was called upon to take the cross-section of the road at the point of the culvert installation and to design something adaptable to the conditions. After taking his cross-section the Engineer requested the manufacturers of the culvert to furnish an addition as soon as possible. This addition was to be thirty feet in length and fitted with two elbows, in order to make a drop in the culvert of eleven feet, and thus get it down to the elevation of the ditch line on the lower side, as shown by the accompanying cross-section.

This culvert was manufactured and



Installing the 30-foot Armco corrugated culvert described in the accompanying article, Clarke County, Iowa.

delivered to the railroad for shipment within eight hours of the time the order was received by the factory and was promptly installed by the county. The accompanying photograph shows the workmen finishing the installation.

A large number of installations of this type are in use in Iowa in places where it is necessary to get a permanent and economically installed culvert which will take care of a difference in elevation between the ditch lines on the upper and lower sides of the culvert.

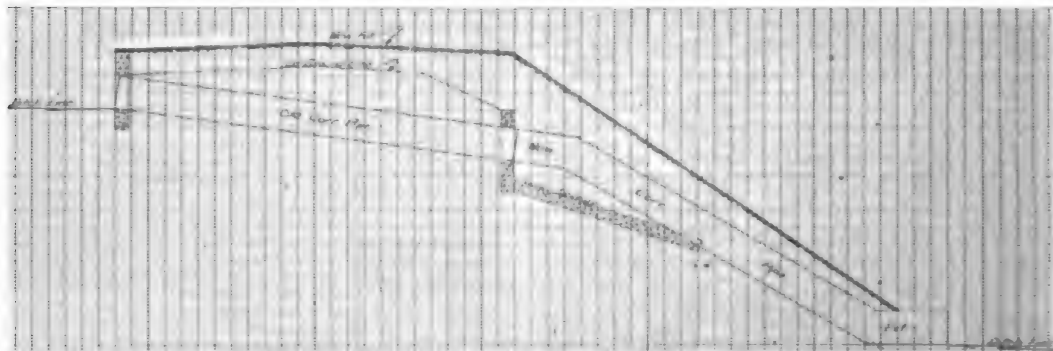


Diagram showing the cross-section of the road at the point of the culvert installation described above, showing the old ground line, the new fill, the old Armco culvert, and the new 30-foot addition.



The above highway, a few miles from Chicago, a market of nearly 3,000,000 people, is now one of Cook County's paved trunk highways.

What Cook County's Paved Roads Have Done for the Farmer

An Interview with MAJOR GEORGE A. QUINLAN,
Superintendent of Highways, Cook County, Ill.
By T. C. HART

"THE most important road in the world is the road that leads from my house to the mill." With that, his favorite quotation, Major George A. Quinlan prefaced his story of what Cook County's paved roads have done and are doing for Cook County's farmers.

Then he continued, "Cook County has at the present time 297 miles of paved roads and 37 more miles are contracted for. About seventy miles of these roads are located in what might be called the corporate limits of cities or villages; about 227 miles are located in the strictly farming communities.

"In the old days the road from the farmer's house to the mill was simply a trail that wound around through the prairies or forests, dodging streams, lakes and hills. These roads, or trails, were often impassable, blockaded with snow in the winter and flooded out in the spring and summer, and the farmer often went through all manner of hardships in his trips to the mill or to market.

"And it isn't so many years ago that those very conditions prevailed right here in Cook County.

"A farmer living but a short distance from Chicago had to get up in the middle of the night in order to be in the city

with his produce for the morning market. If he lived farther out in the country he had to start the afternoon before and drive all night. Then followed another all night's drive or half a night's drive to get back to his farm.



Major George A. Quinlan, Superintendent of Highways, Cook County, Illinois.

"Today, over our modern system of paved roads, these same farmers can be in Chicago with their produce hauled in motor trucks, in from thirty minutes to an hour and a half.

"In the case of fruit and perishable vegetables, this ability to get quickly to market means hundreds and thousands of dollars in the farmers' pockets.

"Our County system of paved roads has done what no local community system could possibly do; it has opened up trunk line roads, through-routes from the most outlying sections of Cook County.

"If, however, our paved road system depended entirely upon the paving of roads by the local community units, which, in the case of Cook County is the Township, we would not accomplish the results desired, for every community would pave the roads most important to itself without reference to the neighboring communities.

"That is why, in our county road



Modern machinery and methods have done much for the rapid and economical construction of Cook County's 300 miles of paved roads.

program, we are providing for trunk line roads or through routes. These through routes are then hooked up with the local community roads and in that way every rural community in Cook County is given direct connection with every other community, and with Chicago as well.

"The paved road system does away with the obstacles which the farmer used to encounter in traveling the old roads and trails. Modern and adequate drainage, together with good bridges, eliminates the trouble of overflow and wash-outs.

"Another greatly overlooked benefit which our farmers receive from our paved road system, is the construction of suitable ditches, not only to furnish drainage for the highway itself but for the adjacent farm land as well.



227 miles of Cook County's paved roads are located in the strictly farming communities.

"Furthermore, the farmer can now plan his work for the entire year. He knows that he is going to be able to reach Chicago, a market place of nearly 3,000,000 people, at any season. This enables him to systematize his year's work without having to make allowances for suspended or interrupted transportation.

"The farmers of Cook County are, to a large degree, responsible for the food supply of Chicago.

"Without the farmer the city could not exist; the entire machinery of the world must be fed by the farmer. The better the roads that lead from the farms to the cities, the closer will our city and country population be drawn together, to the benefit of both.

"Paved roads also furnish an opportunity for the city person to go out direct to the farmer's gate and purchase



"Another benefit which our farmers receive from our paved road system, is the construction of suitable ditches, not only to furnish drainage for the highway itself, but for the adjacent farm land as well."

his fruit, vegetables and eggs. Since the expansion of our paved road system, hundreds of roadside stands have sprung up throughout the country. They are run chiefly by farmers' wives and children and are returning a handsome profit to their operators from the sale of fruit, vegetables, eggs, honey and flowers.

"Paved roads have not only made it possible for the farmer to more readily reach the market where he sells his produce but they have also made more accessible the places where he buys his supplies, educates his children and listens to his preacher. Over paved roads his family can easily attend a "movie" or an entertainment in his own local vil-



"Paved roads also furnish an opportunity for the city person to go out direct to the farmer's gate and purchase fruits, vegetables and eggs. The better the roads that lead from the farm to the city, the closer will city and country population be drawn—to the benefit of both."

lage, or they can with a little more time, go right into Chicago.

"Farm life is no longer the desolate, dreary existence it was during the days of the old mud road.

"With an ever increasing development in modern transportation, the country merchant does not have to tie up a huge sum of money in large stocks of staple articles. He can secure his supplies as he needs them and this releases his money so that it can be used for the purchase of a large variety of goods with which to supply the wants of his farmer customers.

"It would be hard to say definitely just how much benefit the farmers of Cook County have received from the County's paved roads. It has been conservatively estimated that land values have increased \$50.00 per acre in the territories served by these roads. Just what the value is to the land itself would be hard to say.

"In short, our system of paved roads has made the farmer's markets more accessible, has increased his ability to market more produce, has helped his lands gain proper drainage, has made the social side of his existence more pleasing and his amusements more accessible, has

linked him with the city and with his neighboring communities, has made it easier for him to secure his supplies, made it possible for his merchant to give him a wider field to pick from, aided in the education of his children and made life generally more worth while.

"Cook County's paved roads thus far have cost about \$6,500,000 and the benefits to Cook County farmers alone have been many times the cost."



Hard surface highways make it possible for the transportation of goods both to and from the farm, in all seasons of the year and under all weather conditions.

A Successful Two-Strip Type Highway

By CHARLES W. GEIGER

Contra Costa County, California, with forty miles of completed two-strip highway, finds this unique type of construction more economical to build and maintain than other hard surface types.

ONE hundred and twelve miles of concrete highways and twenty-five miles of oil macadam pavements have been built by Contra Costa County at an expenditure of more than \$4,000,000, which is a striking example of community spirit, effort and determination—an object lesson for other counties of the United States.

In order to understand just what this extensive and comprehensive highway construction program means, attention should be called to the fact that Contra Costa County, proportionately, has received less assistance from the California Highway Commission than any other county in the state.

One innovation, the work of County Engineer R. R. Arnold, which has received favorable comment, is the two-strip system of highway construction shown in the accompanying photo. This type costs less than the standard 18 foot concrete road, but provides a total road width of 24 feet. It consists of two 8 foot slabs of concrete with a center strip four feet wide of oil macadam and two 2-foot oil macadam shoulders at the sides.

The two-strip type of highway is safer for night driving because of the

plain demarcation of the road. At all times the traffic is confined to the proper line of travel. From an engineering standpoint the road is a decided improvement on former construction.

Transverse cracks in the pavement are expected in California. Contra Costa's climatic conditions obviate the expense of metal expansion joints. Natural expansion, due to temperature fluctuations, causes cracks to appear in the newly laid concrete which are sealed by an oil filling. The longitudinal cracking, however, presents a grave problem. Once the fracture along the center of the road has appeared in the old type of highway, no successful means has been found for preventing a continual expansion at the joints and an ultimate breaking down of the material on the line of cleavage.

Forty miles of the two-strip construction have been completed and opened to travel in Contra Costa County. Some of this roadway is carrying the heaviest traffic in the county. No failures of any kind have occurred. The slight maintenance cost necessitated in repairing the oil macadam shoulders and center is far less than the average maintenance cost of attempting to repair the standard concrete highway.



The above photograph shows the two strips of eight-foot concrete, the center strip, four feet wide, of all-macadam, and the two-foot all-macadam shoulders on the edges of the road, described in the accompanying article.



A sixteen-foot paved highway in Lenoir County, North Carolina. This pavement was laid and tested under the conditions described in the following article.

A Testing Method That Insures Perfect Pavement

By ARTHUR J. PEEL, Consulting Accountant

The State of North Carolina has spent \$50,000,000 on highway construction during the past two years. In order to insure full value received for every road dollar spent, the State Highway Commission has adopted a pavement testing scheme that absolutely prevents the construction of hard surfaced roads that do not come up to specifications.

AMONG the many accomplishments of Julius Caesar was that of good road building. In England, France, and other nations of Europe, are still to be seen the traces of his handiwork. It is significant, therefore, that Italy, once the seat of the Roman Empire, which was held together by its network of fine highways, should send over to this country one of her foremost engineers to find out how the United States builds durable roads.

In this matter, attention has been directed particularly to the state of North Carolina, which has spent nearly fifty million dollars during the past two years on hard surface roads.

However, mere expenditure of money is hardly sufficient reason for attracting the attention of other states and countries to a road program; it is the quality of the roads which North Carolina is building that is interesting the world.



Mr. Frank Page, Chairman of the North Carolina State Highway Commission.

For this feature of quality, no small credit is due to Mr. R. L. Oberholser, a Pennsylvania chemist, who has used a new adaptation of an old principle in road-building.

Mr. Oberholser has had the encouragement and support of Mr. Frank Page, Chairman of the State Highways Commission, and Mr. Charles Upham, the chief engineer; otherwise he would never have been able to demonstrate a theory which has advanced the science of bituminous road construction to a place where all guess work is eliminated when it comes to the question as to whether uniform density has been maintained in the building of a road.



Mr. Chas. Upham, State Highway Engineer of North Carolina.

The practice of taking tests to determine the quality of the material and the surface condition of a newly laid road,



A fine example of what North Carolina is doing with her \$65,000,000 road bond issue, and her daily testing program.

is not a new one, but it has been proved that material and surface tests are no guarantee that correct density has been maintained throughout the entire stretch of road.

Even when the material is according to the specifications and the surface looks good, the mixture which has gone into the road may fail to bind properly. Where this is the case there is bound to be trouble long before the road has run its allotted span of life.

This problem, Mr. Oberholser grappled with for years and then saw that in order to insure a lay which would be uniformly within ninety per cent of the theoretical density established by a test of the formula used in the mixing, there was but one method to adopt, and that was to take a daily density test.

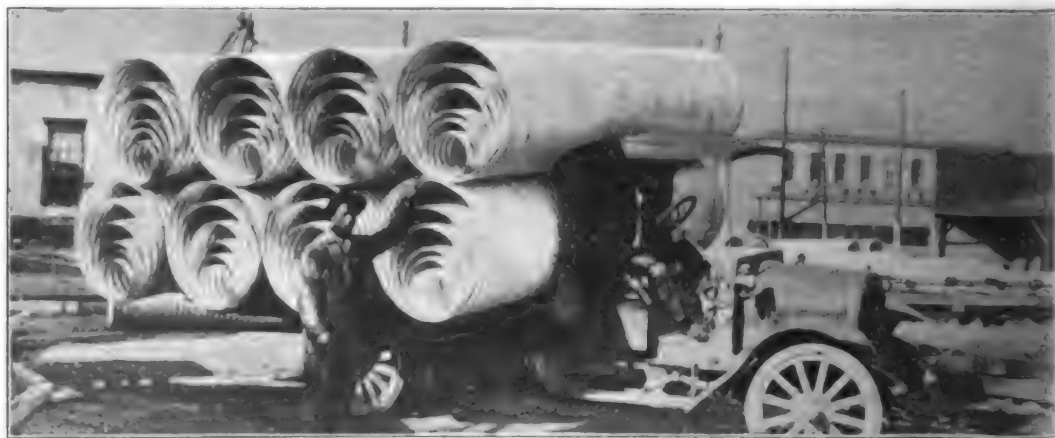
While others were trying to discover some sure and certain means of securing uniform density, Mr. Oberholser seized on an existing method and applied it each day instead of at irregular and lengthy intervals. The results obtained have justified the method. From each road project in the State, the chemical laboratory of the State Highway Department is receiving daily a piece of the road drilled from the day's lay. If the laboratory test reveals poor density, the work is stopped immediately.

By this means poor construction cannot continue on any road for more than twenty-four hours. After the cause of the trouble has been discovered, the condition is remedied, and where it is considered necessary, the stretch of road laid that day is torn up.

When it is remembered that a mile of bad road would cost the state, the county, or the township, \$12,000 to re-surface, some idea will be gained of the importance of this new method of ascertaining the actual condition of the work day by day.

The value of this method has been fully appreciated in North Carolina, and by other states which have followed its example.

To the taxpayers of North Carolina, this innovation in the business of road construction means a great deal. It means that for the first time in the history of road-building, the people who pay the bill are getting full value for every dollar of taxes or bonds for road purposes.



Adequate drainage is an all-important feature in the construction of good roads. The above photograph shows a truckload of Armco ingot iron culverts en route to the point of installation.

Irrigation and Drainage

Reclaiming a Mississippi Swamp

How a large inundated area, in the Lake Cormorant Drainage District, at Penton, Miss., was drained by blasting ditches with dynamite.

IN swampy regions, where the nature of the terrain precludes the possibility of ditching the land by ordinary methods, in order to secure proper drainage, the use of dynamite in opening ditches often proves effective.

How this method works out in heavy gumbo soil covered with water, is strikingly illustrated in the accompanying photographs.

At Penton, Mississippi, in the Lake Cormorant Drainage District, which is in the Northwest corner of the state, within a

few miles of the Mississippi River and the Tennessee state boundary line, it was found necessary to construct a ditch 3,750 feet in length in order to turn worthless swamps into valuable farming land.

Holes three feet deep were placed 18 inches apart. Two cartridges, one of 40% and one of 60% dynamite, were placed in each hole. Blasting was done by the propagated method. The result is shown below. The ditch was accurately cut 10 feet wide, 4 feet deep and 3,750 feet long.



(Courtesy The Hercules Mixer.)

Above at the left the dynamiters can be seen loading the holes for the blast. A good idea of the size of the swamp and the depth of the water can be gained from the picture. At the lower left is another view of the swamp. Below at the right is seen a typical ditch blast. Above is shown the accurately cut ditch which resulted from the shot. This ditch was 3,750 feet long, 10 feet wide, and 4 feet deep.



A big Armco ingot iron flume carrying water across a ravine and broken land on a Montana irrigation project.

Fine Crops on Flathead Irrigation Project

Adequate water supply is proving a big factor in good crop yields on the Camas Division of the Flathead Project in Montana.

CONSTRUCTION of the Camas Division of the Flathead project in Montana, comprising 10,500 acres of irrigable land, will be completed this year under the proposed program of work. This division was opened for settlement in 1910, largely in 40-acre farm units. Delays in securing funds for construction and difficulty in delivering water through canals and laterals, on account of a peculiar sinkhole formation in the soil, prevented the entrymen from having assured water service until the year 1921, although some water was delivered in 1919.

The crop report of 1922 shows 2,650 acres irrigated and cropped, of which 915 acres were alfalfa hay and seed and 590

acres in new alfalfa with a nurse crop.

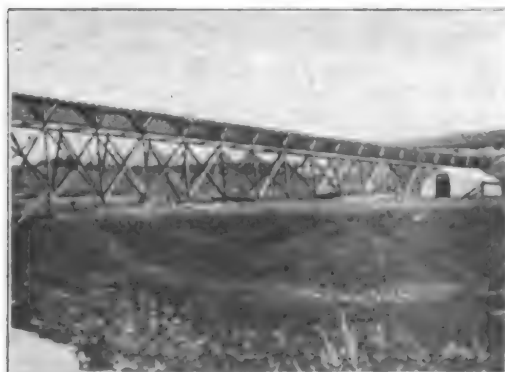
The average gross crop value in 1922 was \$24 per acre, an increase of \$10 per acre over that of 1921.

The farmers of this division had their first annual fair at Lonepine in September, 1922, and showed a remarkable display of grains, hay, fruits, and vegetables. The fruit display of berries, plums, prunes, grapes, peaches, pears, apples, etc., showed the advancement of the fruit culture of the country.

The prize-winning exhibits were taken to the county fair and again carried off first honors. The best Guernsey heifer also took first honors at the Montana State Fair.

The Camas Division is surrounded by large areas of grazing land which furnish pasture for sheep and cattle. The farmers have sized up the situation and are going strong on the raising of seed crops for which the land and climate appear well suited.

The handful of the original entrymen who remained on their land after waiting ten years for water are beginning to make real the visions they had when they first entered the Little Bitterroot River Valley. Some who left before water was available are returning. Many new farmers are coming in, attracted by low prices of land and by the opportunities offered. With the completion of the Hubbard Reservoir this year and the assurance of a good water supply, it is anticipated that this valley will show a rapid development.



The above Armco ingot iron flume, which was installed on the Fort Shaw reclamation project in Montana several years ago, is in perfect condition and giving good service today.

Solving Drainage and Irrigation Problems in the Oldest Irrigated Section of America

By B. F. CLARK
Special Correspondent for *The Highway Magazine*

In the following article, specially written for The Highway Magazine, Mr. Clark tells some interesting facts of the past and present, in connection with the oldest known irrigation project in America.

A LONG the Salt River Valley in Arizona may still be traced the distinct outlines of the first irrigation ditches ever dug in what is known as America. So ancient is the time in which these ditches were dug that archeologists and historians alike are not yet certain what race of early Americans constructed them. It is believed that these irrigation projects were engineered by a somewhat civilized race—perhaps the descendants of the ancient Cliff Dwellers—for the ditches are so scientifically arranged in regard to the contour and fertility of the land, that the modern farmers find it practicable to run their new ditches over the remains of the ancient ones.

It is strange that these ancient people with only crude stone tools to work with, should worry and toil, irrigating arid land, when there were millions of acres of good idle land lying in the rain belt a little farther east. We also wonder why the early Spaniards should first settle on the barren deserts along the Rio Grande Valley where nothing could



A supply ditch adjoining a paved road in the Salt River Valley of Arizona—one of the first irrigation ditches ever dug by white men in America.

be raised except under irrigation systems entailing hard labor.

In the county of Bernilillo, in the state of New Mexico, there are thirty thousand acres of irrigable land lying along the Rio Grande River Valley. Eight thousand acres of this fertile land have been under irrigation for many years. Due to the fact that most of the remaining twenty-two thousand acres are, at times, almost drowned out with seepage water, some sections of the valley will have to be reclaimed before they can be farmed successfully.

The excess water lying so near the surface of this rich land arises from two causes. The substratum in many localities along this valley is composed of a coarse sand. Where land lies only a few feet above the level of the river-bed, seepage takes place from the river.

There are many other plots of comparatively high land which are subsident to other irrigated lands. These adjacent plots have been drowned out by long and continuous over-irrigation of the higher plots.

The Bernilillo County Agent, and other county officials, have a reclamation



An old floodgate manipulated by a discarded wagon wheel, on an ancient irrigation project in Arizona.



A portion of the low lying area of land on the Rio Grande River Valley, which has been drowned out with seepage water. The reclamation project described in the accompanying article will turn this salt-grass land into valuable farms.

project in view which, when put into practice, should eliminate the alkali and salt grass, which at the present time predominates in these marshy areas.

The average fall of the Rio Grande River is five and one-half feet to every one hundred feet where it crosses Bernilillo County. The irrigable belt along the valley is from a mile to three miles wide. The plan is to run a deep ditch clear across the county on each side of the river. These ditches are to be run parallel with the river and as near one thousand feet from it as the contour of the land will permit.

The river runs almost due south at this point and the supply ditches run very nearly in the same direction. This necessarily causes the laterals to be laid out in an easterly and westerly direction. Many of the subjacent plots referred to above, lie considerably higher than the river bed, and yet lower than some of the irrigated fields between them and the river. There has previously been no way to drain these low lying fields which are separated from the river by higher ground. The proposed ditches, running as they will, lower than the lowest lands, will not only drain these low plots, but will form an outlet in which may be emptied the unused waters of the supply and lateral ditches which collect in level places and seep out into the surrounding land.

The varieties of produce raised in this old irrigated valley are numerous. The largest acreage is sown to alfalfa, and planted to fruits of various kinds. As alfalfa will endure more alkali and water than most other plants, it is usually sown on the lower lands, while the higher and dryer lands are planted to orchards and truck gardens. The river, having the rapid fall that it does,

makes it comparatively easy to irrigate lands lying above the river bed. This is done by tapping the river far above the high places to be irrigated, and running the supply ditches around the slopes of the foothills, allowing them to fall just enough to keep the water running.

There are several different methods of irrigation used in Bernilillo County; the flood system being ordinarily used for orchards and alfalfa, or on lands that are shaded or not liable to bake, while the furrow or the corrugation system is usually used in truck patches, or on loose land that does not bake easily.

Most of the ditches are kept up by the community which they serve; each farmer being taxed so many days' work for the number of acres he has under irrigation. The supply ditches are looked after by a maredona, or a ditch overseer, as he is more usually called.

Many of the smaller, well improved ranches in this valley sell for as high as two and three thousand dollars an acre.



An Armco ingot iron flume carrying water on a southwestern irrigation project.



Look for this Blue and Gold Armco Label on Washing Machines, Stoves, Ranges, Refrigerators, Enamel Table Tops, and other household and commercial utilities. It carries with it the assurance of the quality and solid worth of the sheet metal parts of articles that bear it.



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THE AMERICAN ROLLING MILL CO.

MIDDLETOWN, OHIO



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If this triangle were a sheet of ARMCO Ingot Iron, this little dot would represent all impurities. If it were the least bit larger by the addition of any other material, the iron could not bear the ARMCO Trade-mark. There is less than 1 part impurities to every 113 parts of pure ferric — less than 3 ounces to every 10 pounds of pure iron.

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The HIGHWAY MAGAZINE



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The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIV.

NOVEMBER, 1923

No. 10



When all traffic ceases on the world's busiest corner. Eleven o'clock on Armistice Day at the corner of Madison and State Streets, Chicago, Ill., 46,000 people and 2,000 vehicles move through this intersection in a single rush hour. An office building within a block of this corner discharges 5,600 people during a single hour every evening. Traffic experts claim that this is "putting the camel through the traffic needle's eye."



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LOUIS A. GRAHAM, M.E.....Consulting Editor

Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Uniforms For Protection

NO, the man in the picture isn't being sworn into the Ku Klux Klan—he's working. In fact, he's just an ordinary police officer directing automobile traffic in Newport, Rhode Island.

But why the pillow slip with sleeves, or is it part of a sheet he's wearing? Neither—it's merely a neat white tunic worn for protection by all traffic policemen of this exclusive city, so that they may be readily distinguished by passing motorists whenever there is rain or fog.

The unfortunate and singular circumstance of a traffic officer on duty being killed by an unseen motorist during a rainstorm in Newport recently, prompted city officials to adopt this measure of providing protection.

Here is certainly an idea which should be spread, in view of the vast increase in traffic difficulties which continue to multiply daily. Statistics show there are over ten million motor driven vehicles in the United States and a population of slightly more than 100,000,000 persons. The men who stand in the middle of the crowded street intersections directing all these cars every day deserve the added protection of a uniform that is clearly visible under all conditions.

Preliminary Plans Made for 1924 Road Show

FROM interest manifested by exhibitors and state highway officials, the 1924 convention of the American Road Builders' Association will be greater than any previous one, according to Charles Upham, convention manager and state highway engineer of North Carolina. Already preliminary plans for the convention and the Road Show have been made and certain blanket contracts entered into for moving machinery to the Coliseum in Chicago, where the show is to be held.

The Road Show is to be held from January 14 to January 19.

The Congress Hotel has been selected as convention headquarters where the daily meetings and the annual banquet will be held. The organization for handling the Road Show in 1924 will be somewhat similar to that which functioned this last January.

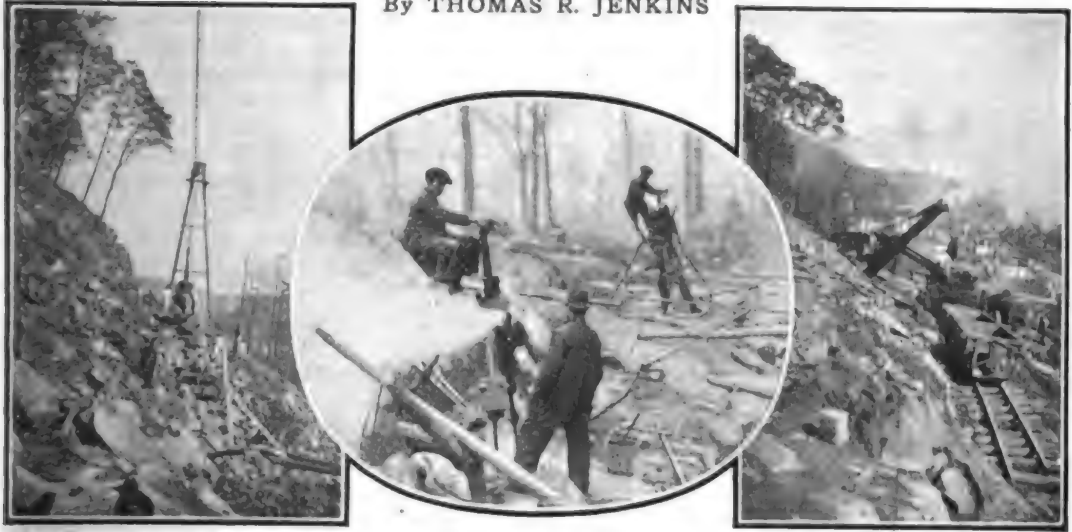


Courtesy Motor Age.
This unique garb has been adopted by traffic officers of Newport, Rhode Island, as a measure of protection, since a traffic officer was recently killed by a motorist during a heavy fog.

Blasting a Road Out of the Face of the New Jersey Palisades

Based on interviews with C. A. Burn and Roy Mullins, Engineers in charge of construction.

By THOMAS R. JENKINS



The above photographs show typical scenes during the process of blasting a road out of the New Jersey Palisades, as graphically told in the following article.

NOT alone because its construction developed an opulence of engineering high lights, but also from the standpoint of the picturesque and romantic, one of the most interesting stretches of main highway in the East is the new road from the ferry terminal at Edgewater, New Jersey.

From the foot of the Palisades it winds up and around the side of a formidable cliff that sweeps majestically into an awe-inspiring headland a mile or so north—at every point within sight of a great river below and a greater city just beyond.

The maps showing the tentative route were prepared by Roscoe Parke McClave, Bergen County Engineer, and presented to the New Jersey State Highway Department, which constructed the particularly interesting part of the route up the sheer face of the Palisades. The Bergen County authorities constructed the stretch from the brink of the Palisades westerly to Anderson Avenue. All in all, Route 10, as it is officially known, embodied construction of ap-

proximately eleven miles, and, though the shortest of the entire State Highway System, strange to say, it was most prolific in varied constructive features.

Section 1-A of this new artery of traffic, which was thrown open to the public last Spring, extends from the ferry to the crest of the Palisades; Section 1-B continues from that point across the commanding plateau of the cliff; Section 2 winds quite gently down the western side of this highland out into the Hackensack Valley; and Section 3 carries the route across the famous Hackensack meadows. Thus within a short distance of five and a half miles there occurred all the general engineering problems of road construction; namely, heavy rock cutting, construction up the face of a great cliff, extensive earth fills, working down the other more gradual side of the ridge and fills across tide marshes, with their difficulty of unstable bottoms.

However, it is with Section 1-A, begun in the Autumn of 1919, that this article has principally to do. This road's graded

width is 44 feet, while the paved width is 34 feet, plus an 8-foot pedestrian walk. It is mainly constructed in terrace, excavated in rock cuts to a height of 110 feet on one side, representing 75 per cent of the section's length, with retaining walls on the opposite terrace reaching up to a 50-foot height in trenches of 15-foot depth. At the top the retaining walls are of a 30-foot thickness and battered 2 inches to the foot.

The masonry of these brace parapets contain approximately 16,500 cubic yards of rock, at a unit price of \$3.86 per yard; the earth excavation amounted to 14,000 yards at \$1.45, and the rock excavation to 114,000 yards at \$3.39. The rock was very rough, tough, trap formation of irregular seams, and badly weathered, necessitating considerable dressing to remove the loose and threatening fragments that made the road hazardous.

The steep nature and the rough surface of the slope made it difficult to distribute equipment and plant at the intermediate points along the route. The road was only accessible from its lower end, thus entailing an estimated increase of about 25 per cent over what the cost of construction would have been if the road had been accessible from both ends.

The steep character of the bluff lent an adventurous flavor to the work, as the men making the reconnaissance surveys and preliminary drilling and blasting had to be suspended by ropes and work with safety lines and belts.

The upper end of the road saw the commencement of operations at the rect-

angular intersection with an existing highway. The topographical condition here was fairly regular.

Three steam shovels were installed and crews with picks, shovels, and steam drills operated with compressed air from compressors mounted on the steam shovels, served the shovels that attacked the earth, rock and boulders, spoiling the debris along the right of way, which was then delivered to some 40 double-truck, 3-yard dump cars hauled by four 12-ton Baldwin and Davenport locomotives along a 24-inch gauge service track.

Practically all the rock projections had to be shattered by blasting before removal by the steam shovels was possible. The excavation proper was a cut with a horizontal bottom ranging in width from 20 to 50 feet, with an almost perpendicular face on the side toward the hill.

In some instances the waste was deposited directly alongside the cut, building up a fill on the outer margin that widened the grade and diminished the amount of excavation where the topography was of a character to provide a suitable base for the embankment.

At other times conditions were such that it was imperative to make the cut somewhat wider than the prescribed 44 feet so that all the loose rock on the hillside might be trimmed away and leave the exposed surface sound.

For safety's sake the outer rim of the roadway was reinforced by a stout retaining wall whose foundations were extended below the original surface of the ground to protect it from the ravages of frost action and to secure sound supporting rock. The top of the wall was finished with a rubble masonry parapet laid with cement mortar and capped with narrow transverse, horizontal stones 2 or 3 inches apart in the clear, and having sharp upper points to discourage the use of the wall as a promenade or a resting place.

In depth the cut varied from some 25 to 110 feet, and was achieved entirely by undercutting without the employment of any vertical drill holes. Considerable of this work was accomplished with five large sized jackhammer drills and the same number of $3\frac{3}{4}$ inch tripod drills, the latter operated by compressed



A steam shovel working in a cut, reducing the grade at the southern end of Mountain Avenue.



A section of the new road, winding from the foot of the Palisades at Edgewater, New Jersey, to the summit of the old Hudson River Cliff.

air supplied from a power plant at the lower end of the job and delivered through a 2-inch pipe line extending nearly to the summit of the cliff.

Cavities of from 15 to 20 feet long were drilled as close to the bottom as possible and inclined downward from the horizontal about 1 inch in 3 inches. They were sometimes sprung several times and charged with 40 per cent and 60 per cent dynamite.

The toughness, irregular seaming and treacherous nature of the rock made drilling and blasting an operation of extreme difficulty, sometimes necessitating as much as five days to drill, load and explode a series of four holes, which operation would usually break from 500 to 1,000 yards of rock. The nature of the rock dulled the drills rapidly and made the holes cost up to \$1.75 a linear foot.

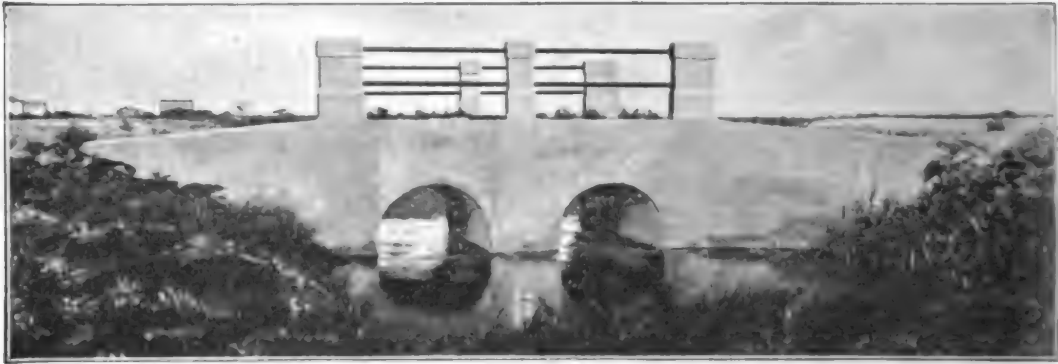
The shovels and three Lidgerwood cableways of 400-foot span, installed at successive points over the alignment of the retaining wall to place the stones used therein, practically handled all the blasted rock.

Besides the equipment already mentioned, an Ingersoll-Rand air compressor of a capacity of 850 cubic feet of

free air a minute to a pressure of 100 pounds, 6,000 feet of 2-inch air line pipe, the same number of feet of 1½-inch city pressure water pipe, an 80 horse-power boiler and a Leyner drill sharpener were installed. The maximum force employed was 125 men, while the average number was about 50. The average pay, including the laborers, foremen and overtime items, was \$7.75 per day.

The total cost of the project was \$515,600. The quantities of the main items were 33,800 cubic yards of ledge rock, 6,800 cubic yards of loose rock, 11,600 cubic yards of earth excavation and 16,100 cubic yards of dry rubble retaining wall.

This road to the plateau of the Palisades, which by the way, is sacred Revolutionary ground, as Washington's tattered army once passed over it, is a less circuitous route from the busy little Edgewater ferry, making it no longer necessary to use the old, narrow, round-about road leading into the unusually steep eastern edge of Fort Lee, a fact which is duly appreciated by the hundreds of thousands of autoists, in business and pleasure vehicles, who annually pour back and forth across the New Jersey Palisades.



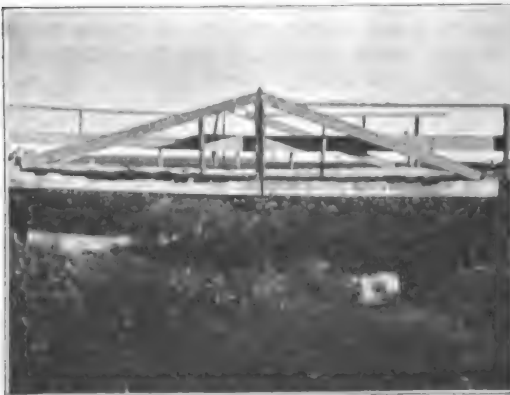
A permanent and economically constructed bridge made of twin Armco culverts, 60 inches in diameter and 30 feet in length, in Holabird Township, South Dakota.

Replacing Wooden Bridges With Corrugated Iron Culverts

How a South Dakota County eliminated two old wooden bridges by the use of corrugated iron culverts, and effected a substantial saving in time and money.

HYDE County, South Dakota, faced a very necessary highway maintenance and construction program in 1922 with rather limited funds.

The County Board of Commissioners deemed it necessary to purchase a carload of corrugated culverts to carry on much needed drainage work. It was also apparent that several new bridges must be built. Money was not available for both the bridge building program and the drainage work, and the problem was put up to former Highway Superintendent Fred Cloeter.



The old wooden bridge on the Holabird Road, South Dakota, which was replaced by the twin Armco culverts shown at the top of this page.

Supt. Cloeter estimated the cost of constructing the two most needed bridges, one in Holabird Township and the other in Eagle Township. He then estimated the cost of replacing these old wooden bridges with large size Armco culverts and found it to be considerably cheaper, and that such installations would also leave sufficient funds for the purchase of the carload of smaller Armco culverts needed in the regular construction and drainage work.

The latter plan was adopted and a 72-inch Armco ingot iron culvert was installed in Eagle Township replacing an old wooden bridge. In Holabird Township, under what is known as the Holabird Road, twin Armco culverts of 12 gauge metal, 60 inches in diameter and 30 feet in length, replaced the old wooden bridge shown in the accompanying photograph.

Another factor which was considered by Supt. Cloeter in his selection of culverts made from Armco ingot iron, not only in the replacement of bridges but also in the regular highway drainage work, was the fact that much of the water in the county is impregnated with alkali, which is highly destructive to ordinary metals and concrete.

Safety Education for Pedestrian and Motorist

By E. G. LAUGHLIN,
Secretary-Manager, Chicago Safety Council.

RECENTLY, when the Chicago Safety Council made the statement that "women are better auto drivers than men" and that they are also "more careful walkers than men," they aroused a hornet's nest of disapproval.

Notwithstanding, the Council refuses to take cover. They face the issue with the firm statement that "the statements are true; it is only that, upon first glance, they might very easily be misconstrued."

During the first six months of 1923, Cook County, Illinois, in which the city of Chicago is located, chalked up a total of 334 street deaths. This report is based upon the coroner's statistics. Of this number, 237 were pedestrians. Seven women drivers were involved in the 334 cases. Among the pedestrians, 264 were men; 70 were women.

Accepting the fact that there are ten men driving cars to each woman driver, the facts nevertheless stand to womanward.

There is, however, another angle of the Council's statistics that is, perhaps, more important than these—one deserving of studied attention.

From December, 1922, to June, 1923, (inclusive) the total death rate from street accidents in Cook County showed



A striking warning sign adopted by the Safety Commission of a Chicago suburb, which has materially aided in reducing the child death rate from motor accidents.

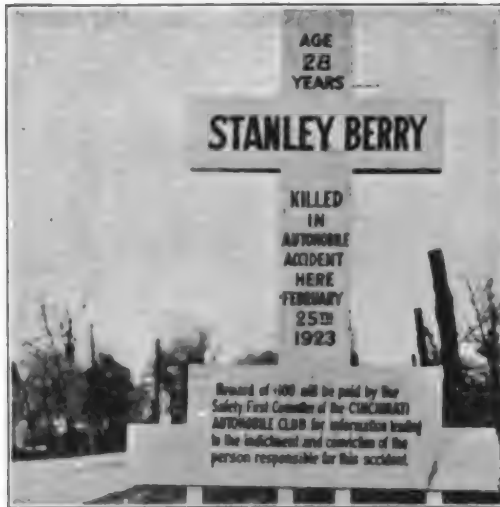
a 6½ per cent increase over the rate of the same period of time of the previous year.

Of this number, the death rate among children amounted to 120 as compared to last year's 139. A decrease of 14 per cent!

The Safety Council attributes this fact to the work accomplished by a little, simply bound book called "Safety Education." There are 450,000 school children in Chicago who follow this book through their elementary years. Every



The above photograph would indicate that the English have a sense of humor. This unique sign gives warning of a very dangerous curve at Hampstead, England.



A grim reminder of a tragic automobile accident, which has helped to prevent many others.

teacher in the 350 schools possesses her own particular text book.

And, because the book, having been compiled by a committee appointed by the Chicago superintendent of schools, incorporates every branch of study represented in the curriculum, it successfully inculcates the idea of safety in the growing mind.

"Safety Education!" Upon this hinges the death rate from accidents in future years. By means of the book children come to compile accident statistics in lieu of the If-a-Farmer-Had-Ten-Sacks-of-Grain-and-Mice-Ruined-Four-of-them idea—a sugar-coated pill of wisdom, a warning that is quickly caught and rarely forgotten.

It is the same with other studies. Grammar slyly picks out the jingles of childhood and makes them over into matters of importance. A case in point:

Little Jack Horner

Stood at the corner
Watching the traffic go by;
But when it had passed
He crossed over at last
And said "What a good boy am I."

Thus, with "Safety Education" representing a regular course of study in the Chicago school system, a marked change for the better in the mortality rate from accidents is anticipated.

Possibly, had the adult world acquainted itself with the contents of "Safety Education," the heavy end of the accident statistics would not lean in that direction. Undoubtedly, this means of education, as introduced by the Chicago Safety Council, would prove as beneficial to grownups as to children.

The book has already gone to all parts of the world. In the United States a large railway company—the North-Western, in fact—is already making negotiations for placing "Safety Education" before the schools of the towns along its lines.

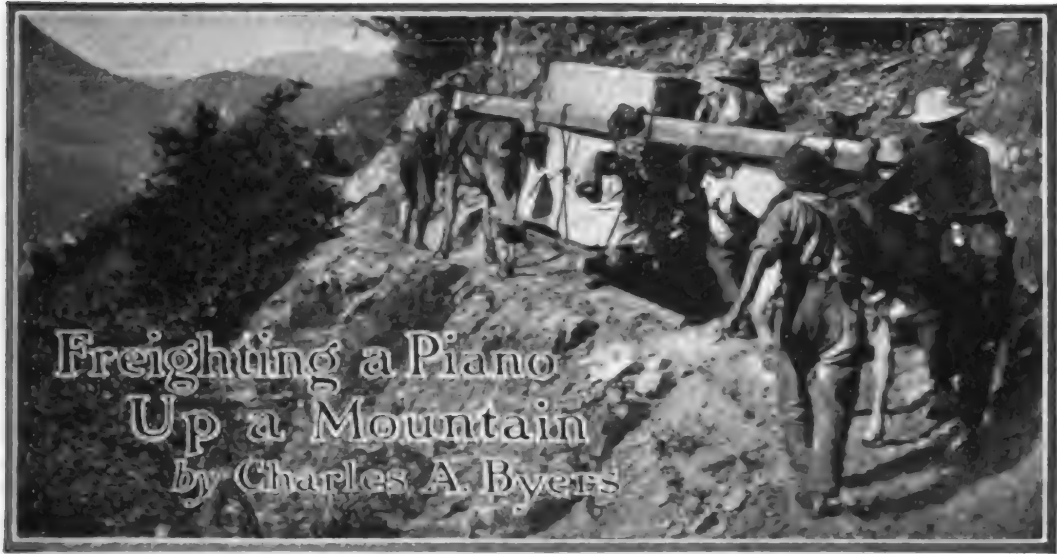
Harry J. Bell, retiring secretary-manager of the Chicago Safety Council, advised that "there is no better way for a woman to show mother love than to devote at least a short time every day to instructing her children as to the dangers that lie between the two sides of the street."

It is the objective of the Council to eventually place a copy of "Safety Education" in the hands of every mother in America.

Only through education in the home and the school can the child death rate from motor accidents become materially less.



A clever cartoon that formed a part of a metropolitan newspaper's campaign against reckless automobile driving. (Courtesy The Chicago Tribune.)



On the road to Switzer's Camp. The tiny pack mules, guided by mountaineers, are seen negotiating the narrow trail up the mountain side.

ABOUT fifteen miles north of Pasadena, Cal., is a mountain resort known as Switzer's Camp, access to which is possible only by way of a narrow mountain trail. This trail zig-zags back and forth in its ascent of the precipitous sides of mountains, and crosses and recrosses several times a small canyon stream.

All freighting to and from the resort must be done with burros, for the use of vehicles of any kind, because of the trail's narrowness and roughness, is utterly impossible.

Recently the owner of the mountain resort wanted a piano, and evidently he wanted it badly. He was compelled to pay for and superintend the delivery of it himself. But being a real mountaineer the problem was by no means as difficult of solution as it might have seemed to some people.

Fastening the instrument securely between two long timbers, and then strapping the ends of the timbers to the backs of two burros, a workable method of transportation was quite easily devised.

Drivers steadied the load and guided the animals, and the delivery was thus made without mishap or a great deal of

difficulty, although in places the trail made such sharp turns as to threaten the pushing of one end or the other of the burro train from the narrow trail. The accompanying photographs taken by the author, who took part in this unique transportation problem, give a good idea of the difficulties encountered in transporting a piano up a mountain side without the aid of good roads.



Crossing a mountain stream at the start of the climb. The trail was so narrow and circuitous that on some of the sharp turns the pack mules carrying the piano were nearly pushed from the mountain trail.

What Shall We Do With the “Jay-Walker”?

The American Automobile Association presents statistics to prove that the motorist is not always to blame whenever an accident occurs, and suggests a penalty for the inveterate "jay-walker."

WHENEVER an automobile strikes an individual, the curses of the world fall upon the head of the driver of the car.

Very frequently the blame is rightly placed. Quite as often, it misses the mark. The American Automobile Association plans to correct the situation.

The cities are crowded with "jay-walkers"—wilful men and women who stubbornly refuse to obey the traffic rules, and, in the face of certain disaster, calmly pursue a "catty-corner" course across the street.

These are generally people who are dead set against automobilists as a whole. They believe that the driver of a car must be sufficiently alert to avoid them in any extremity.

How often this common error sends a motorist hurtling against the pavement!—for the second instinct of all men is a certain kind of chivalry, the chivalry that would protect the less fortunate.

Various motor clubs throughout America are launching campaigns against "jay-walking." It is not in the nature of a public reprimand, but rather a plea to the good sense of pedestrians.

Aside from the Public Safety organizations, the Automobile Club of Southern California and the American Auto-

mobile Association, with headquarters in New York, have been active in launching the necessary propaganda against the "jay-walker."

M. O. Eldridge, executive chairman of the latter organization, has, with the aid of a chart summary of accidents in New York City, compiled the following interesting data:

Fifty per cent of the causes of accidents remain unknown. The blame in the cases where the fault has been determined, overwhelmingly placed itself upon the injured one.

According to Mr. Eldridge, over a certain period of time in which 7,327 accidents, involving private automobiles, occurred, the police department of New York City found by thorough investigation, that in 450 cases the driver of the machine was to blame. In 3,168 cases, the person injured was to blame; in 3,683 cases the cause of the accident was unknown.

The American Automobile Association suggests a state penalty for "jay-walking," to be provided in traffic legislation.

It is maintained that, if motorists must be fined for disobedience of traffic signals, "jay-walkers" should be punished quite as readily.

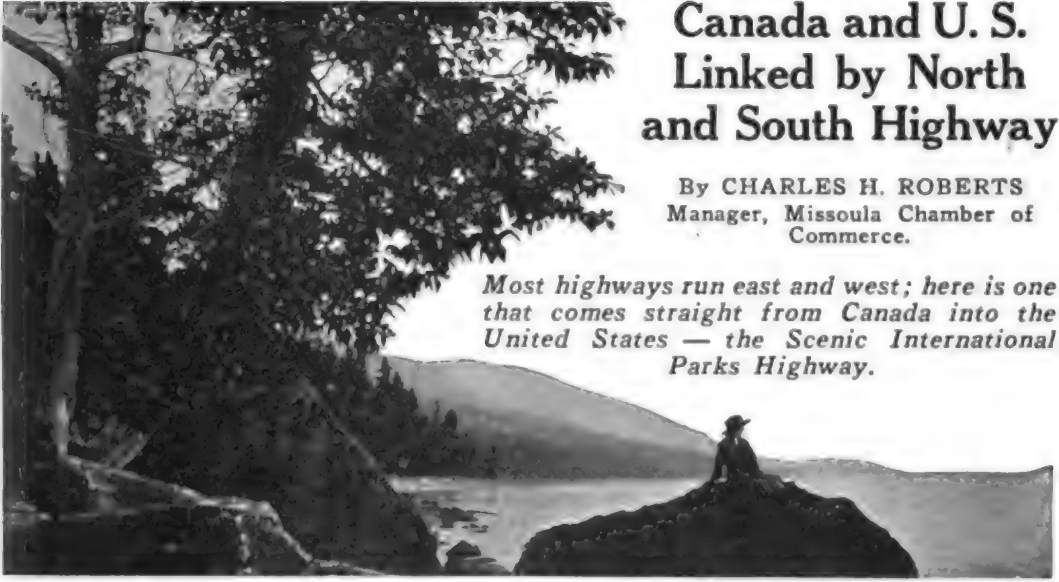


A portion of the exhibit of the Bureau of Public Safety, held in the Grand Central Palace of New York in connection with the New York City Jubilee.

Canada and U. S. Linked by North and South Highway

By CHARLES H. ROBERTS
Manager, Missoula Chamber of
Commerce.

*Most highways run east and west; here is one
that comes straight from Canada into the
United States — the Scenic International
Parks Highway.*



The route of the Scenic International Parks Highway follows the shore of beautiful Flathead Lake in Montana.

THE Scenic International Parks Highway Association, the most recent organization to foster the development of a north and south highway, was organized in Missoula, Mont., last July.

There are many highways stretching east and west across the continent; few that run north and south.

Scenic International Parks Highway will connect up approximately 1,300 miles of Pacific Slope mountain beauty, extending from beautiful Lake Louise in the heart of the Canadian Rockies, south, through the American Rockies, via Flathead Lake, through western Montana, southeastern Idaho and Utah, to Salt Lake City.

During the organization sessions, it was impressively said: "Nowhere else could more that is beautiful and impressive be found than along this trail—beauties strung like countless jewels."

A road has been in existence over the entire route for a great many years, but until the organization meeting in Missoula, a straight north and south highway had been little thought of. Of exceptional interest to the tourist, is the fact that this north and south highway intersects a very large number of the

famous east and west highways of the country.

The U. S. Forestry Service, the U. S. Bureau of Public Roads, the British Columbia Government, and various famous highway associations—all will co-operate with the Scenic International Parks Highway organization in building up this destined-to-be-famous road.

In Canada the highway will connect up with four Canadian National parks: Waterton Lakes, Banff, Kootenay and Yoho.

Coming south into the United States the route of the proposed highway crosses the international boundary at Gateway, passes through a region of lakes, rivers, mountains and forests, similar in character to the topography of Glacier Park, and continues practically to the western entrance of Glacier Park at Belton.

Traveling north from Salt Lake City the highway follows the "Corrine Trail," the old immigrant route of stage coach days in western Montana. This old trail extends from Salt Lake City to Alder Gulch near Dillon—the romantic relic of a city once made famous by mines that have passed into obscurity. Between Idaho Falls and Dillon stretches a section of the highway once made ter-



Drainage is an important factor on the mountain roads of Western Montana. An Armco culvert installed under a new road in Powell County, Montana.

rible to coaches and peaceable citizens by reason of road agents and outlaws.

Leaving the western gateway of Yellowstone the new road enters a beautiful wilderness. Here rise the headwaters of the Mississippi.

Through the famous Centennial Valley, along the Bitter Root Mountains, into Monida, winds the highway, meeting here the Oregon Short Line and the principal road to Salt Lake City. The line of the railroad is kept to Armstead, and from Armstead the way leads to Dillon.

A little further along begins the fertile Big Hole Valley. At Jackson the tourist will find excellent natural hot baths. Further on is Wisdom, where a little army of regular troops and Montana settlers defeated Chief Jo-

seph and his Nez Perce Indians in 1877.

From Wisdom across the Continental Divide into the lovely Bitter Root Valley, an easy grade leads at last into the Bitter Root at Medicine Hot Springs. Thence the highway runs straight down the famous valley, rich in grain and orchards, through Hamilton and Stevensville and a dozen smaller towns, to Missoula. Then from Missoula out across the Flathead Reservation to the north—along that great fresh water lake, Flathead—to Polson at the southern end of the lake—onward to Kalispell—and from Kalispell to the gateway of Glacier

Park; thus runs the route of Scenic National Parks Highway to the north.

There can be no question of the future popularity of the north and south scenic International Parks Highway.



The Scenic International Parks Highway traverses a land famous for its historic interest. Above, Big Hole Battleground Monument, Beaverhead National Forest. Left, an old Jesuit Mission, Stevensville, Montana. Right, a scene on the Bitterroot-Bighole road.



Irrigation and Drainage

Moving a Town to Build Greatest Irrigation Reservoir

The Minidoka Irrigation Project, which is part of the Federal Irrigation Development at American Falls, Idaho, calls for the removal of a city and a railroad to a new location in order to build a dam that will impound 3,000,000 acre feet of water.

JUST above the point where the Oregon Short Line crosses the Snake River in Idaho, stands the town of American Falls.

Government engineers have established the fact that conditions at this point are favorable for the construction of a dam of any height up to 90 feet. At this elevation 3,000,000 acre feet of storage can be developed. This capacity is greater than that of any existing artificial irrigation reservoir in the United States, Elephant Butte, the largest one so far constructed, having a capacity of only 2,600,000 acre feet.

The stored water will permit the irrigation of several large tracts for which water has not heretofore been available, and provides a much needed supplemental water supply for large areas now dependent upon the unregulated flow of



Armco ingot iron flume ready to be installed on a new irrigation project in the far Northwest.

this stream. The proposed reservoir would be a part of the Minidoka Federal irrigation project. It is planned to irrigate about 115,000 acres of public land under that project from the reservoir. The total area now irrigated in



A view of the town of American Falls, Idaho, which will be entirely moved to a new site in order to make way for the construction of the largest reservoir in the U. S. The reservoir will have a capacity of 1,500,000 acre-feet.



Guy Flenner, head of the Idaho Reclamation Association, who put over the American Falls Reservoir project.

the Snake River valley from the waters of the Snake River and from waters of its tributaries above American Falls is 1,300,000 acres, and the tracts that may ultimately be added to the irrigated area probably aggregate 500,000 acres more.

The creation of this reservoir involves not only the construction of a dam and the purchase of rights of way, but in addition the removal of most of the town of American Falls to a new location above the reservoir level, the relocation and reconstruction of about two miles of railway, and the adjustment of existing power rights at the dam site.

Co-operative contracts, providing for capacity in the reservoir, have been

made between the United States and the following irrigation districts:

American Falls Reservoir District,
Empire Irrigation District,
Milner Low Lift Irrigation District,
New Sweden Irrigation District,
Snake River Valley Irrigation District.

Existing power rights at the dam site have been adjusted by contract with the Idaho Power Company, the new town site of American Falls has been laid out, and the appraisal and purchase of lands within the reservoir site is in progress.

The beginning of actual construction work must await the availability of additional funds which are to be provided in part under the above named co-operative contracts and others being negotiated, and in part by Congressional appropriation. Assuming that construction begins at the earliest practicable moment, it will be two or three years before this project is completed.

The estimated cost of the entire work is \$12,000,000.



A large Armco ingot iron flume carrying water across a deep ravine on an irrigation project in Washington.



A view of the low-lying marsh land which was drained by use of Armco pipe and Calco drainage gates, as described on the next page.

Increasing Land Values by Controlling Silt Deposits

The following article describes a simple method by which the levels of tidal and river lands have been raised several feet without labor and at minimum expense, resulting in the reclamation of waste marsh land.

HERE is a new method of reclamation—one that holds tremendous possibilities for the owners of tidal and marsh lands everywhere.

During the past six or eight years, experience in several localities on the Pacific coast has demonstrated that wherever a silt-bearing stream flows across marsh land which is inundated at high tide, the waters of the stream may be so controlled as to cause them to deposit their wealth of fertile soil in even layers over the tract and in a comparatively short time to raise its surface materially and wholly transform its character.

The salts with which the soil is saturated are leached out by successive floodings with fresh water. Land that produced nothing but crabs and salt grass half a dozen years ago, has passed through the various stages in which oats and barley were harvested, and is now fit for such definitely upland crops as clover and corn.

After a few more seasons it will doubtless be utilized for carrots, beets, cabbage and other market garden specialties. Meanwhile its value has risen from a merely nominal figure to that of the best agricultural land of the region.

The method is simple and involves a minimum of labor and investment. A dike is thrown up along the water front to protect the land from the sea water at high tide. A corrugated iron pipe is run through the dike at the natural outlet of the stream, and this is fitted with a cast iron automatic gate on the outer end.

When the water in the stream behind it is higher than that in the bay, or slough, the gate is opened by the pressure and permits drainage to proceed. When the tide or the river level rises, the pressure against the front of the gate valve instantly closes it; and, the device being water-tight, no salt water finds its way back on the land.

Under ordinary conditions the pipes and gates act merely to drain the land and protect it against back-flow; but in times of heavy rains or of rapidly melting snow a new condition arises. The pipes have not sufficient capacity to drain away the freshet waters at once, so they spread out behind the dike and cover the land. They are heavily laden with mud and decayed vegetable matter which has been brought down from the uplands, and this, as soon as the water becomes quiet, is deposited over the field, fertilizing and upbuilding it just as do the waters of the Nile in the Egyptian valley.

At the same time the land is thoroughly soaked with fresh water, and a portion of its salt content is leached out



A view of the Calco automatic drainage gate from above, showing the uninterrupted flow of water from the marsh land at low tide.

and eliminated. The repetition of this process through five or six seasons will cause a complete transformation of the land.

The holes and sinks are levelled first and the tract becomes fit for pasturage. Back-flow with consequent re-salting and softening of the ground is prevented.

One large dairy owner, who has developed such land, declares that where it is equipped with pipes and automatic gates he is able to get his cattle upon it from thirty to sixty days earlier than would otherwise be possible, and that the pasturage is very much better. After a few seasons he has been able to plow the tract and sow it to crops that bring much greater returns than those from grazing.

Many acres of this character are protected by wooden tide gates, but these structures have many disadvantages, and are rapidly being abandoned. A fairly good gate of this description, built of lumber with wood or steel bearings, is decidedly costly because of the labor involved and the fact that the work can only be performed under low-tide conditions. Furthermore, wooden structures are subject to undermining by crabs and to honeycombing by marine borers, and often fail in a very short time. Wooden gates are heavy and cumbersome in action, and a very decided

difference of water levels is required to open or close them. The result is that for some time after the turn of the tide the gate remains partly open and allows considerable quantities of salt water to flow back upon the land.

The effective action of dikes and automatic drainage gates in building up lands by silt deposits is by no means confined to seashore areas. There are many locations along river valleys where all the conditions discussed above are present except the saltiness of the tidal marshes; and the gates are employed in the same way to protect the lands and to build up their levels.

When heavy rains occur, the muddy freshet waters accumulate behind the dam and for a few days form a shallow pond over the marsh. As soon as this water becomes still, it deposits its silt on the land, and then is drained off through the pipe. In a few years a beautiful and fertile meadow will take the place of the marsh, and clover, alfalfa or corn will be flourishing on an area that formerly produced only cat-tails, mosquitoes and bullfrogs.

The beauty of this method of reclamation of either fresh or salt marshes is that old Dame Nature herself does most of the work, and the landowner's returns in the form of added values are altogether out of proportion to the money and time he has invested.



The above section of tide land was built up two feet in six years through silt deposit control. Note the upland grain crops and wild flowers on an area which formerly grew nothing but salt grass.

ARMCO **INGOT**
TRADE MARK **IRON**
FOR GAS AND ELECTRIC WELDING

When Iron Runs Like Melted Butter

A gaping crack or a break in the iron! Five to six thousand degrees of heat blazed into the crack until the iron melts! Then the welding metal flows into the open space, makes a perfect union with the broken iron, and the break is healed.

Welding is not like sticking together two pieces of wood with glue. In welding, the iron that is used to fill the crack must become an inseparable part of the iron that is broken (or of the two parts that are to be joined.)

"Armco" Ingot Iron makes a perfect union. Impurities that might prevent this have been removed from "Armco" Ingot Iron, permitting the tiny molecules to hug one another closely.

The same basic purity which makes "Armco" Ingot Iron perfect for welding, insures resistance to rust.

Culverts made of "Armco" Ingot Iron are guaranteed 99.84 per cent pure, and will resist corrosion under the most adverse conditions.

Thousands of "Armco" culverts, corrugated to add strength, and covered with a two ounce coating of galvanizing per square foot of metal to give even greater resistance to corrosion, are in perfect condition today after a decade of service.

Write for Needed Information



The American Rolling Mill Company

MIDDLETOWN, OHIO

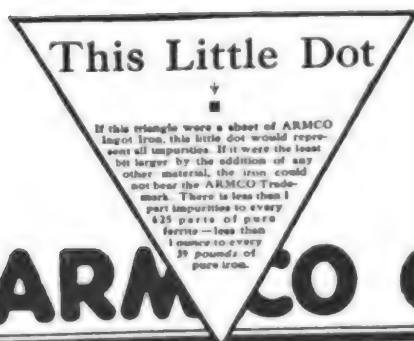


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cord tires or fabric?
Cord costs more.

Do you buy
wool clothes or shoddy?
Wool costs more.

Do you buy
full-leather shoes or papered?
Full leather costs more.

Do you buy
ARMCO Ingot Iron or "near-
pure" metal?
ARMCO costs more.

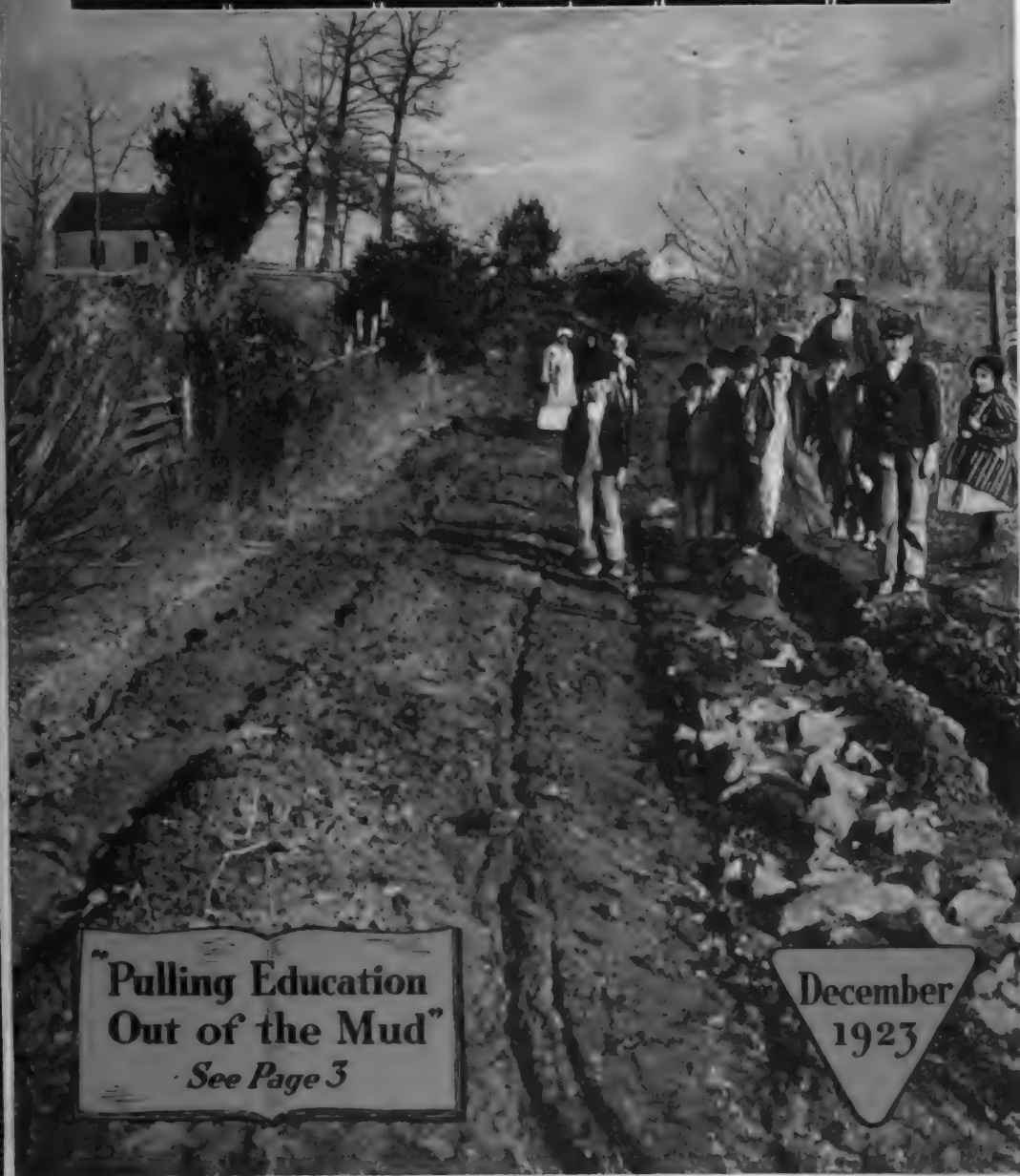


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The HIGHWAY MAGAZINE



"Pulling Education
Out of the Mud"
See Page 3

December
1923

**Write to the nearest manufacturers for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock The Dixie Culvert & Metal Co.	Nebraska, Wahoo Nebraska Culvert & Mfg. Co.
California, Los Angeles California Corrugated Culvert Co.	New Hampshire, Nashua North-East Metal Culvert Co.
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Florida, Jacksonville The Dixie Culvert & Metal Co.	North Dakota, Wahpeton Northwestern Sheet & Iron Works
Georgia, Atlanta The Dixie Culvert & Metal Co.	Ohio, Middletown The American Rolling Mill Co. The Ohio Corrugated Culvert Co.
Indiana, Crawfordsville The W. Q. O'Neill Co.	Oklahoma, Oklahoma City The Boardman Co.
Iowa, Des Moines Iowa Pure Iron Co.	Oregon, Portland Coast Culvert & Flume Co.
Iowa, Independence Independence Corr. Culvert Co.	South Dakota, Sioux Falls Sioux Falls Metal Culvert Co.
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The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIV

DECEMBER, 1923.

No. 11

Highway Memorials

At the right is shown a photograph of the Harding Way, framed in a heavy copper frame weighing 100 lbs., which was presented to the late President Harding. Harding Way, is one of Montana's beautiful highways.

Below, at right is a boulder which the D. A. R. have dedicated on the Dixie Highway near Hoopston, Ill., to the memory of Gordon S. Hubbard, one of the earliest white settlers and traders in Illinois, who was the first man to pass over what was known for many decades as the Hubbard Trail, but of late years known as the Dixie Highway.



At left is the Portage Trail Monument at Akron, Ohio. The Portage Trail, several miles in length, on which the Indians carried their canoes from the Cuyahoga to the Tuscarawas rivers on the journey from the Great Lakes to the Ohio river, passes through Akron. This trail was one of the best known Indian highways and formed part of the western boundary line between the colonies and the Indian tribes.



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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

New Texas Motor Law Expected to Double Revenue

IT is estimated by the State Highway Department that the new motor fee law which went into effect last June will bring a revenue more than double that which was obtained under the old law, or approximately \$10,000,000 annually. Of this sum three-fourths goes to the state highway fund for improvement and maintenance and the remaining one-fourth to the available school fund.

What "Operating" Means

THE chief of police of a Massachusetts city telephoned to the delivery manager of the leading department store on the leading business street.

"One of your trucks is standing down on Parker Street," the chief said.

"Well, is that the unpardonable crime?"

"Not quite; but there's a law in force in this state that says that no automobile shall be operated on any street after dark without a light."

"And you say the truck is standing still?"

"Yes."

"Is the engine running?"

"No."

"Well, if you can make out that a truck standing still with the engine shut off is being 'operated,' you're certainly some lawyer," the delivery man retorted.

"I'm no lawyer," the chief came back, "but the supreme court of Massachusetts says I'm right."

And the guardian of the law actually was right. In the case of Commonwealth vs. Henry, 118 N. E. Reporter, 224, the Massachusetts supreme court decided that a law forbidding the "operating" of an automobile without headlights under certain conditions, applies to a stationary car with a "dead" engine.



Drainage is an important factor in the construction of the beautiful mountain roads of California. The above photograph shows a 36-inch Armco culvert installed in Santa Barbara County, California, near Gaviota.

Pulling Education Out of the Mud

By CHARLOTTE DOLLY

Special Correspondent for The Highway Magazine

How good roads and modern transportation are solving the problem of the rural school, through consolidation.

WITH the agricultural population moving cityward at the rate of 460,000 annually, the question arises as to the cause.

The U. S. Bureau of Education solves this particular angle of the problem in this way: "Lacking the training which a supervisor could give, the rural teacher fails to inspire the most intelligent progressive farmers with confidence in her ability. These farmers realize the lack of educational opportunities provided by their one-teacher schools and, as a result, they move to towns so that their children may get educational advantages."

In the national effort to provide consolidated schools in all counties, the government states that "poor schools mean cheapened communities and lessened farm production."

Also, the cost of supporting a high school for a very few pupils is prohibitive. Two high schools in a western state reported per pupil costs of over \$1,000 per year for 1921.

Larger units of support must displace, the small district school.



Roads like this increase school transportation costs, to say nothing of delays and danger in getting children to school.

A large number of the 19,813,435 elementary pupils in America still continue in the badly constructed, poorly arranged one-teacher rural schools.

The plan of the consolidated, or centralized schools, eliminates the sluggish



Good highways have made possible the modern library on wheels, which fills a real community need. This unusual library is run free by the Hamilton, New Jersey, Township Library Commission.



A beautiful Florida highway near Miami, which is part of a consolidated county school route.

difficulties which out-of-the-way communities have faced since the laying of the first schoolhouse log. It eliminates the poor little building, the poor, lonely little teacher who finds it very difficult, indeed, to spend her days instructing as few as half a dozen—sometimes one or two—children. It sweeps away all the drudgery, all the disinterest which farmers' children are bound to show in such surroundings; and, in addition, it allows a good teacher to draw a good salary without imposing upon a poorly instructed teacher a salary quite as poor, which, nevertheless, chalks up the district school expenses to a ridiculous sum at the year's end.

It is a case of conserva-

tion of the highest order, for what is a nation's greatest asset save the school children?

The wise wife of a school superintendent argues: "Running six small schools in a county where consolidation is possible, is just as unbusinesslike as if a large farmer were to buy six small farms, lying miles apart, and operate each with the full equipment of a single unit."

A flimsy argument against the consolidated school, with its full high school curriculum, plenty of books, educational clubs, and noon lunch facilities, is the question of transportation. Individuals who fall back upon this, however, are referred to the state laws regarding this sort of thing.

Forty-three states make special provision for the transportation of pupils living at remote distances from consolidated or city schools.

In twelve states transportation is mandatory. Thirty states leave the matter up to the trustees. Ten states provide that the people themselves shall decide upon the mode of transportation. It must be remembered, however, that there are states in which one agency of transportation may be more agreeable or necessary than that in other districts.

It is at this point that one great national system crosses and becomes a distinct part of another. *Without good roads the best of transportation facilities would be negligible.*



Good roads have marked the passing of these antiquated one-room school houses. Above is Upper Salt Creek School No. 38, Hope County, Oregon. At the left is a school house in St. Louis County, Minn., which is being replaced by a modern consolidated school. At the right is a Kentucky log school house which was used until 1910.

The Bureau of Public Road states that there is a close connection between the improvement of roads and the consolidation plan. Good roads, they believe, usually come first, though in some cases the school plan must be used as an argument, with the end in view of building the new and improved highways.



Four very good examples of modern consolidated schools, which are, in reality, community centers as well as institutions of learning. Each con-



tains its auditorium, cafeteria, administration office and class rooms. Such union schools are solving the problem of education in rural districts.

Kansas State Normal School, Emporia, Kansas, sends out the frank assertion that four different districts all see the need of good roads, and are falling in line to have them—"something we probably never should have gotten had it not been for the consolidated schools."

One progressive measure brings another; and if good roads are needed they will surely follow in on the heels of the new system. "This is particularly true," states the Department of School Consolidation, "where busses are using the roads daily and the road condition is brought to the attention of every person in the consolidated district." The cost of bus transportation is minimum, amounting to a fraction over fifty cents per pupil per month.

It would seem, on the face of it, to be a great and profitable plan.

A glimpse into a consolidated school should convince any frozen skeptic of its efficiency. The Union High School,

in Mount Vernon, Washington, is a splendid example of the new system. Its main building contains an auditorium, cafeteria, administration and class rooms. In Washington there is a law that takes excellent care of the transportation problem.

Down in Madison County, Alabama, the Monrovia consolidated school building is quite new. Trucks bring to this school 125 children daily. St. Louis County, Minnesota, is replacing its old No. 68 with a school on the consolidated plan. Transportation in Wisconsin is mandatory, with certain inflexible rules governing the mode of transportation, and the conduct of the driver.

In Florida the county boards of education are authorized to dictate transportation facilities.

The coming of consolidated schools has made possible the improvement of many highways.

Solving San Francisco's Grade Problems

Spiral roadways and switchbacks with easy grades facilitate automobile and street car traffic on the hills of the Golden Gate City.

UNIQUE in construction is the new spiral roadway with which Lombard Street, between Hyde and Leavenworth Streets, San Francisco, Cal., has been paved.

The construction method used consists of a winding retaining wall between the parallel property lines, against which an easy grade with banked turns is constructed. Part of the sidewalk space is used to make the turns wider.

The spiral street reduces the straightway grade of 27 per cent, which is a death trap, to the grade of 16 per cent which can easily be navigated by automobiles.

This construction method stands as the city engineer's solution of the street paving problem presented by San Francisco's seven times seven hills.

Lombard Street residents plan parking of the area between the curves, installation of ornamental electroliers, brick stairways along the sidewalk, and ornamental seats.

The photograph above shows another novel improvement in hillside streets made at the expense of both city



A switchback with easy grades which facilitates both automobile and street car traffic in San Francisco.

and street railway company. Here the railway used a switchback for ascending the hill. The track descending the hill occupies the entire width of the cut and was hardly practicable for vehicles. By slightly changing the track alignment and building retaining walls, the roadways were widened and the section made accessible for vehicles, and the appearance at this point was greatly improved.



A view of Lombard Street, California, from the top of what was a 27 per cent grade, but which has now been reduced to a grade of 16 per cent which can be easily navigated by automobiles.

Road Building in the Grand Canyon of Arizona

In constructing highways, motor roads and trails throughout Grand Canyon National Park, the government has opened up a veritable wonderland that is becoming the mecca of thousands of tourists annually.



A view of Hermit Rim Road, Grand Canyon of Arizona. The oil macadam pavement was resurfaced last summer to take care of the heavy tourist traffic.

SINCE the establishment of the Grand Canyon as a National Park and the opening of its marvels and beauties to the nature-lover by roads and trails, there has developed a tremendous increase of travel in the region.

People come by thousands, on trains and wagons, by saddle horses and afoot, and, above all, by automobiles, to traverse the winding and precipitous trails to the river bed, to clamber up the rocky foot-paths to famous lookout points and to motor along the great level stretches of the rim roads.

These include many points of vantage whence appear mighty vistas of distant canyon walls, foaming cataracts, painted deserts, and far-away, evergreen forests.

During the past year 7,890 automobiles brought 25,470 people to view the Grand Canyon, while the Santa Fe railroad brought 59,230 visitors. Many foreigners of note have visited the Canyon. Some of the recent notables are Marshal Foch, the Prince of Wales, Lord and Lady Mountbatten and the King and Queen of Belgium.

It is perhaps more true of the Grand Canyon than of any of the other natural wonders of America that it absolutely must be seen to be appreciated. Many

travelers have gained fairly adequate ideas of Niagara Falls and even of the Yosemite from pictures and descriptions, but all agree that all their previous knowledge left them wholly unprepared for the sight of the Grand Canyon.

Their first emotion on beholding it was that of amazement; and this was not lessened, but rather increased, by long continued contemplation and the gaining of many successive viewpoints.

Grand Canyon National Park contains 958 square miles. The canyon, which is the greatest example of erosion in the world, is 217 miles long, 56 miles of which are within the park. The gigantic gash in the earth's surface which we know as the Grand Canyon is the work of the Colorado River through thousands of years. From rim to rim the distance varies from eight to twenty miles. The canyon at Park Headquarters is approximately 6,000 feet deep. On the north rim is the Kaibab National Forest, or Presidents' Forest, so ably described by Emerson Hough. This is the largest remaining stand of virgin timber in the United States.

Many streams empty into the river through or over the walls of the canyon. Clear Creek comes in over a chain of



From the top of the Grand Canyon of Arizona, looking down 6,000 feet at the Colorado River below.

four falls with a total drop of 429 feet. This creek has its beginning in a cave. Altar Falls are 10 feet higher than Niagara, though, of course, not to be compared with the northern cataract in volume of water. They are called Altar Falls because they have created an altar 84 feet high, of surpassing beauty, the formation resulting from the lime in the water.

Three tribes of Indians, the Hopi, Navajo and Supai, live partly within the park boundaries. Adjoining the park are other reservations in which live thousands of the native Indians. Many are

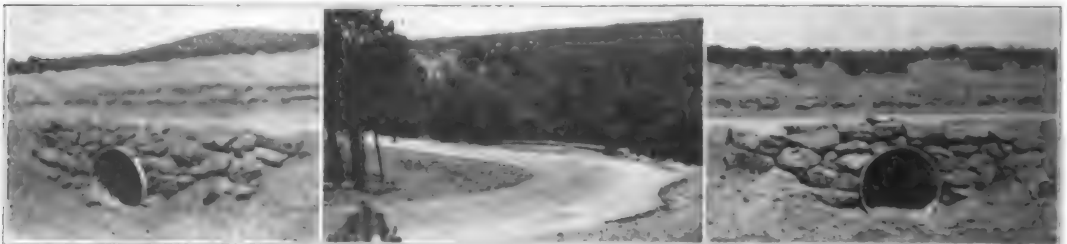
more or less nomadic and move from one place to another in search of feed and water for their sheep or cattle.

There are 120 miles of road within the park, eight miles of which were lightly paved with macadam. The greatly increasing traffic has made it necessary to repave these sections this year with much more substantial construction. Road building and repair are constant activities of the Park forces, and the place abounds with examples of notable highway engineering. In handling the drainage problem, Armco ingot iron corrugated culverts are used for all the smaller and medium-sized waterways. The rim roads that skirt the chasm are the admiration of numberless visitors. A branch of the National Old Trails Highway connects with the Canyon road system, and this is thronged all summer long with the cars of nature students and travelers.

Many keenly interesting things are to be found in the Canyon by one who has the courage for exploration.

The river is not navigable because of the many rapids, although two or three parties have traversed its course with many hardships and hair-breadth escapes. The narrative of these adventures reads like an Homeric tale of the wanderings of Ulysses.

Among the natural wonders of the world the Grand Canyon is unsurpassed. As long as men traverse the American continent it will be visited by awed and delighted throngs. The whole great state of Arizona abounds in natural marvels and beauties, and the student of history and archeology finds there an inexhaustible field for research, now made easily accessible through the construction of adequate roads.



Three views along the Grand Canyon Trail of the National Old Trails Highway. At the right and left are shown two of the many Armco culverts which drain the roads bordering the Grand Canyon.

The Road to Timbuctoo

By Orin Crooker



"He had paid two dollars to a truck driver for pulling his car from its semi-submerged position."

THE man at the wheel resented strongly the presence on the seat beside him of a stranger who had slipped into the car without even so much as "If you please, sir," or "Excuse my forwardness—but I'll miss my connections unless you give me a lift." Ordinarily of a friendly attitude toward others, the man who but a few moments before had paid two dollars to a truck driver for pulling his car from its sad predicament on a submerged piece of road scowled at his self-invited passenger.

"Your name, sir?"

"—is of no consequence," came the prompt reply. "I am a representative of the Society for the Cultivation of Optimism Among Men Who Drive a Car. A membership in our organization renders one proof against the annoyance of punctures, blowouts, engine troubles, poor gas and bad roads. Your recent experience, which I chanced to observe, suggests that this is perhaps the psychological moment to solicit your interest in an investment guaranteed to pay more inflated dividends than ever have been promised by an oil prospectus. All you need to do is to sign on the dotted line."

"Not so fast, stranger," objected the man at the wheel. "I'm not from Missouri—but I've got to be shown. If your organization can render this bus of mine proof against such roads as I

have met with today, I'd fall for a membership. But I'm in no humor to stand for any foolishness. In fact, I think you'd better get out." He stepped on the brake.

"It's not the 'bus,' as you call it, that we fortify in matters of this sort," corrected the stranger. "It's your own state of mind to which we minister. Poor roads oftentimes are unavoidable. However, the Society for the Cultivation of Optimism Among Men Who Drive a Car regards any kind of a road as better than no road at all. There is always hope, you know, that a road will freeze up or dry up or otherwise become passable if one waits long enough. What you need, if I may make so bold as to suggest, is a more generous realization of the fact that you have more to be thankful for in the way of road conditions than perhaps you suspicion."

"Stuff and nonsense," exclaimed the man at the wheel with rising temper, "don't you see I'm wasting gas waiting for you to remove yourself?"

"Not so fast," purred the mysterious one. "Suppose we drive on and let me satisfy your Missouri instincts. This stretch of road between here and Timbuctoo has converted unbelievers who wear a harder shell than yours."

Reluctant to settle the issue by physical force, the driver started his car.

"Just around this bend directly

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ahead," volunteered the unwelcome passenger, "we come to a stretch of sand that has been made as easy going as a Brussels carpet, by the generous spreading of straw. Did you ever ride on anything quite so velvety?" he asked a few moments later as the car rocked gently over the unique roadway.

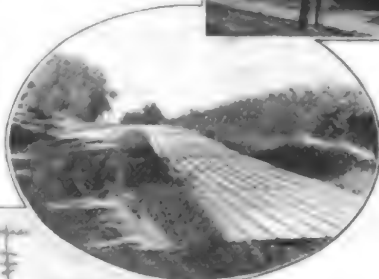
"Some road!" replied the man at the wheel, though he tried to conceal his enjoyment of the novel experience. "Never drove on anything softer," he felt forced to admit as he turned out of the straw-spread portion of the road to pass a disabled flivver in which a solitary woman kept vigil.

"This bit of road improvement, crude as it is, has helped many a driver to realize that most roads aren't quite so bad as they might be," asserted the stranger. "But I have another example to show you just a little beyond where this sand leaves off. Here we are," he observed, as the car approached a curious looking spot in the road. "It's too bad the thundershower you encountered a ways back went around this spot. I'd like to show you a real mud-hole and carry you over it without wetting a spoke. You'll have to imagine the mud. But the plank flooring will show what I mean—you fellows have more to be thankful for than you imagine."

The man at the wheel nodded approvingly as the car spun smoothly over the stretch of planking.

"There's a bad piece of clay right ahead," observed the stranger. "Never dried up smoother than a washboard until they began oiling it. I see they're getting ready to give it another dose."

"You have to imagine the mud, but the plank flooring will show what I mean." He pointed to several sprinkler wagons being filled with oil from a tank car."



He pointed to several sprinkler wagons being filled with oil from a tank car. "You fellows who find fault with the roads forget that they might be a whole lot worse. But we've got to detour here," he continued, as they reached the end of the oiled stretch. "The state is putting in concrete from this point into town. I'm overcome whenever I contemplate it."

"How so?" The man at the wheel turned upon his companion in surprise.

"Because it marks the end of my life work." The stranger brushed a tear from his cheek. "When all our roads are surfaced in this way there'll be no further need for the Society for the Cultivation of Optimism Among Men Who Drive a Car. You know how it's been in other ways. Tires have twice the life they used to have. Punctures are growing scarcer every year."

"My work is almost done! Hard roads are all that stand in the way of complete happiness for most folks. And eventually they will come—a l m o s t everywhere—as certainly as the rising of the sun on the morrow." He took his handkerchief and wiped his eyes. "Slow down, friend. Here's where I get out. That's my house up there among the trees."

"What! That beautiful brick house?"

"Yes. I don't occupy the whole of it; there's plenty of room for you and welcome waiting—anytime."



"We've got to detour here. The state is putting in concrete from this point into town. When all roads are surfaced, there will be no need for the Society."

The man at the wheel waved the mysterious one a goodbye. As he did so his eye noted a sign over a nearby entrance.

"Insane Asylum!" he exclaimed aghast. "May be so! But I've seen crazier folks than my friend who's going up the path. Anyhow, his Society for the Cultivation of Optimism Among Men Who Drive a Car isn't such a bad idea after all."



Building a Million Dollar Private Road Through the Florida Everglades

By Hamilton M. Wright

The famous Conners Highway, reaching out across vast swamps and jungles on its way to Lake Okeechobee.

SPENDING a million dollars from his own private funds in order to build a concrete highway half way across the impassable Florida Everglades is what W. J. Conners, Buffalo millionaire and former chairman of the New York State Democratic Committee is doing.

His highway is 51 miles long, extending from West Palm Beach to the town of Okeechobee, crossing some of the most treacherous soft muck and flood water lands in the United States. The feat is said by engineers to be a remarkable engineering accomplishment. When the road is completed Mr. Conners will be able to reach his vast estate near Okeechobee in two and one-half hours from Palm Beach. To pass through the swamps and jungles to Okeechobee from the coast in the old days took anywhere from six weeks to three months, and even today is a tremendous task.

Mr. Conners' undertaking is stupendous. It was necessary for him to build his own rock crushers and provide dredges and equipment in an impassable wilderness. The swamps have been especially heavy with rains this year, adding to a dozen other drawbacks that would stop the progress of most any

road builder. But Conners has not allowed this to delay his work.

He promised the Florida State Legislature that the road would be finished by December 1, 1923. This was started with the understanding that the Legislature would build the other half of the road—a highway from Lake Okeechobee to the west coast of Florida. A road that will make the East coast and the West coast a matter of about a three hours' auto ride.

Engineers and laborers have worked night and day to keep the promise to the Legislature. They have been paid an average of \$60 per week, totaling a payroll of about \$40,000 monthly. This does not include the upkeep of the 74 trucks, or the six eight-ton gasoline locomotives, the fifteen steamboats, and the seven land-excavating machines costing well over \$400,000.

Famous engineers pronounce Conners' feat the greatest achievement of its kind in road construction, from an engineering viewpoint, that has ever been accomplished. To understand the difficulties of building a road through the Everglades, it is necessary to review the cause and origin of the enormous swamps.

Lake Okeechobee in the central



A road gang at work on the Conners Highway, four miles from Okeechobee City. Leaving Lake Okeechobee, the road turns toward the Atlantic coast in its course through the Florida Everglades.

southern part of Florida is one of the largest bodies of fresh water entirely within the limits of the United States. This lake is fed by a water shed draining down from the north.

During heavy rains the Kissimmee River and other streams and lakes raise the level of Okeechobee with the result that it overflows its southern boundaries and the water inundating the whole country, escapes toward the sea.

It is through this flooded region that the new road is being constructed. The surplus water of Lake Okeechobee is lowered by great canals cut from the lake to sea level. The highway is following one of these canals for a part of the route. It is a tremendous task to lay a road bed in such wet, mucky land. The foundations must be deep and an enormous amount of rock is required. The prettiest piece of white ribbon is a road on the southwest bank of the Palm Beach Canal. This road was made from the white rock excavated from the bed of the canal, which is marl, being 90 per cent lime.

The dynamic energy of the Conners' forces is amazing Florida. They are in the work heart and soul and pull together like a championship football team. They are building a road over territory in which adventurers sometimes faced death from starvation, when they were forced to cut their way through the tangles of the thick underbrush.

The Conners' Highway, as it will be known, will provide an outlet for 1,670,000 acres of rich land, 50,000 acres of which have already been reclaimed and are susceptible of agriculture and 25,000 acres of which are already under agriculture. Mr. Conners owns more than 40,000 acres in this rich country and is creating a marvelous estate on this rich land that is as rich as the Nile or Euphrates.

So enthusiastic are the landowners in the vicinity of the new highway, that they have donated a 110-foot truss bridge with a swing section which will be put across Taylor Creek, which runs through the town of Okeechobee.



W. J. Conners (in front of truck), supervising the erection of one of his rock crushers, which will supply material for his 51-mile highway.



Flood and Drought Control on the North Platte

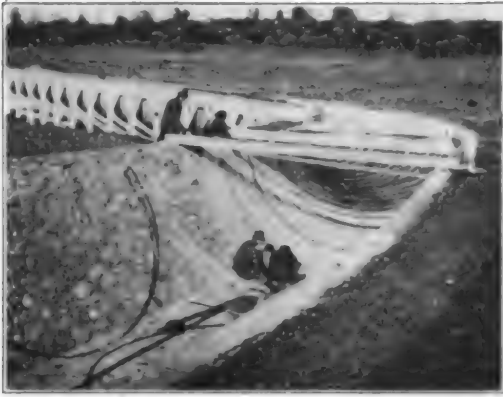
The Pathfinder Project that Will Straighten Out the Water Supply of Southeastern Wyoming.

IF the water hemmed in by the Pathfinder Dam, built across the North Platte River, in Wyoming, were to be uncorked there would be a volume sufficient to cover an area equal to the size of the State of Rhode Island to a depth of one foot. It is one of the largest masonry dams in the world. The immense water-retaining walls rise 218 feet above the rock foundation; the dam is 432 feet long, 10 feet wide on top; 80 feet long and 90 feet wide on the bottom; and contains 60,210 cubic yards of masonry.

The watering plan of the North Platte project provides for the storage of flood waters in a reservoir controlled by the Pathfinder Dam, built across the North Platte River, 50 miles southwest of Casper and 100 miles northeast of Cheyenne, Wyo. It is the second largest irrigation enterprise of the Reclamation Service of the United States Department of Interior, the Boise project in Idaho being the largest. At present, 145,000 acres of farming lands are being reclaimed to productive uses, and once the plans have been completed 252,000 acres



The Pathfinder Dam, one of the big links in the North Platte control system, is built across the North Platte river, 100 miles northeast of Cheyenne, Wyoming.



Installing a huge Armco ingot iron flume on one of the great irrigation and power projects of the West.

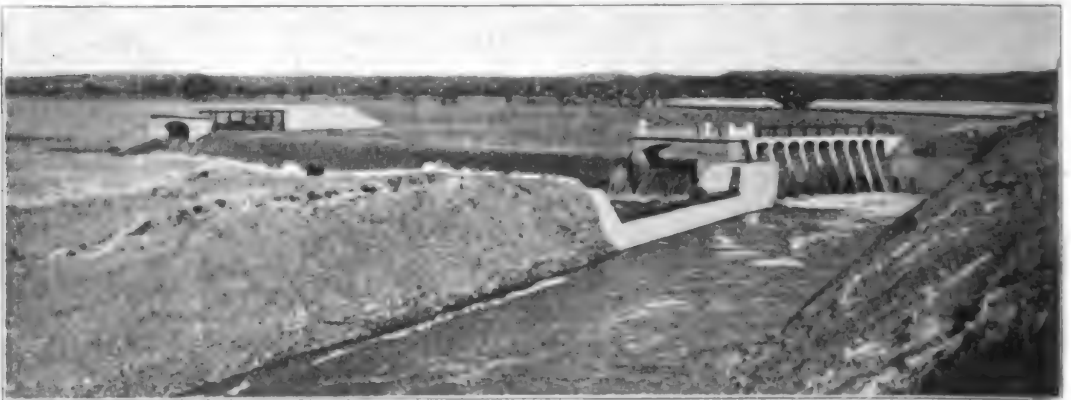
of ground will be redeemed to agricultural production.

The reservoir is a receptacle for the drainage of 12,000 square miles. It extends for 22 miles up the North Platte River and for 13 along the Sweetwater River, the artificial "pond" being located at the junction of these two rivers in central Wyoming. The area of this water-retaining tank at the level of the spillway is 22,000 acres and its capacity is 1,070,000 acre feet. The spillway exceeds 600 feet in length at an elevation of 184 feet above the stream bed. The river has an average run-off of 1,400,000 acre-feet at the Pathfinder Dam. Heavy snows in the winter and the subsequent flood waters in early spring may vary this figure considerably. The run-off

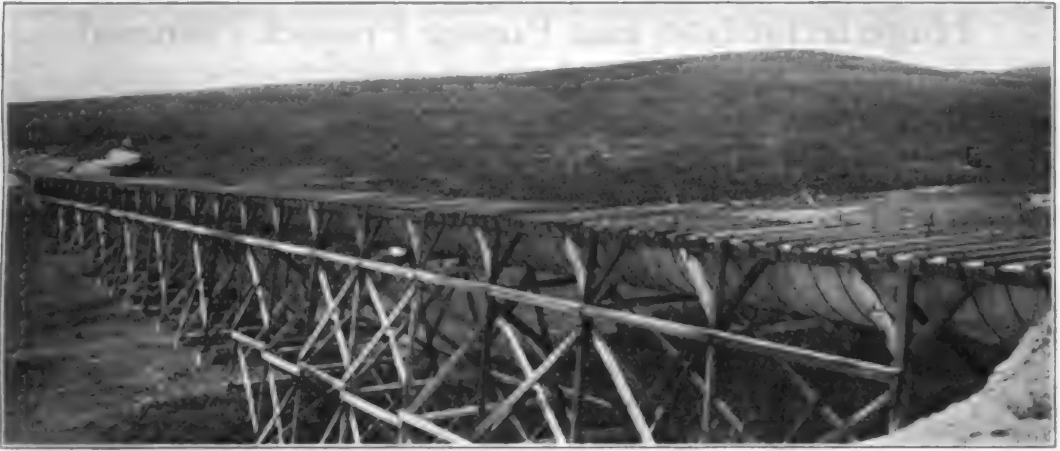
during one season was 1,000,000 acre-feet in excess of the average run-off.

The Pathfinder Dam takes its name from a tradition that General John C. Fremont, popularly known as "Pathfinder," once passed through the canyon at the reservoir site on one of his exploring expeditions. This deep, narrow canyon is on the North Platte River three miles below the mouth of the Sweetwater River and 50 miles from Casper, Wyo., the nearest railway station. The Pathfinder Dam is an arched masonry structure, the radius of the center line of the top being 150 feet. Its top is surmounted by a stone parapet or protection wall four feet high and two feet thick on the upper face and there is a pipe railing on the lower face. The height of the top of the parapet is 5,864 feet above sea level. The upstream face has a batter of one horizontal to four vertical and the downstream face a batter of one and one-half horizontal to ten vertical. On the north side of the river, with crest at elevation 5,850 or 10 feet below the top of the dam, not including parapet, is a spillway 600 feet long. It was cut in solid rock adjacent to the dam, thus permitting a release of surplus water once the reservoir is full. Not remote from the south end of the huge prison for an artificial water supply an earthen dike has been built to close a gap in the wall of the reservoir.

A curved concrete guide wall extends from the north end of the dam a distance of 108 feet along the side of the



A view of the Whalen Diversion Dam that divides the North Platte river into canals on each side. The dam is 29 feet high, with a concrete wier 300 feet long. The aggregate bulk of the Whalen Diversion Dam totals 80,740 cubic yards.



Rust resisting water-tight Armco ingot iron flume which has been carrying water across a valley on the Fort Shaw project in Montana for several years. It is in perfect condition today and good for many more years of service.

spillway to protect the toe of the dam. Also, a bridge embraces the distance from the north end of the dam to the gatehouse above the service gatehouse to that above the emergency gate shaft. Stones on the face of these massive water-retaining walls are squared and faced, being laid in regular courses with horizontal and vertical joints. On the inside of the structure are to be found oddly and irregular-formed stones, some of which weigh as much as ten tons. These rocks are planted or embedded in cement mortar, with concrete filling up the openings between the stones.

Farming on this reclamation project will involve the growing of alfalfa, oats, sugar beets, potatoes, corn, wheat, barley, and beans. Such is the diversity of crops nurtured by this sandy loam soil. Dairying may be pursued to advantage, and an abundance of alfalfa, sugar beet tops, pulp and waste from the sugar fac-

tory render inviting the opportunity of feeding cattle and sheep as a profitable business. Aside from this, floods have heretofore been of periodic occurrence in this vicinity; a future safeguard will be present in this silent monarch of the stream. Damages from floods, when thus averted, may be a compensating feature equal or probably in excess of the total cost of this reclamation project.



Texas Plans Drainage Reservoir to Benefit 100,000 Acres

A PROJECT involving the construction of a reservoir at Bronte, Texas, that will hold 250,000 acre-feet of water and drain approximately 100,000 acres of land situated in Coke, Brown and Runnels counties, has been approved by the State Board of Water Engineers, according to Chairman Norris of the Board.



Where water is worth its weight in gold. Irrigation is all that is needed to make the above sagebrush land of the far West produce wonderful crops.

Huge Irrigation and Power Project Planned in Arizona

THE Verde River Irrigation and Power District has approved the issuance of \$23,000,000 in bonds for constructing a dual irrigation and hydro-electric project, plans contemplating the storage of 1,200,000 acre-feet of water in two reservoirs and the development of 68,000 horse-power in seven power plants. The district, which will operate under the laws of Arizona, at present comprises dam sites, power sites, canal rights-of-way and 102,000 acres of irrigable land adjacent to and north of the Salt River Valley Water Users' Association—the Roosevelt project near Phoenix. The district has a right to the flood waters of the Verde River, and the amount of the normal flow not diverted by the Salt River Valley Water Users' Association.

Pursuant to the action of the voters of the Verde River District, bonds will be advertised for sale in the near future and construction work will be started as soon as the bonds are sold.

To pay off the bonds from straight irrigation assessments would create a comparatively heavy annual bond charge for a large part of the thirty-year bond issue. In order to make the project more

feasible from a financial standpoint, it is necessary to develop hydro-electric power in connection with the irrigation plans, making a dual purpose project. The two reservoirs make it possible to develop about 200,000,000 kilowatt-hours per year primary power, and there is also about 20,000 additional kilowatt-hours per year secondary power that can be developed by the above plants. There is sufficient market within 100 miles for all of the power and the gross revenue is estimated at \$1,900,000.

The irrigation works include the construction of either a rock-fill or a concrete constant-radius arch storage dam with a maximum height above stream bed of 265 feet and a capacity of 950,000 acre-feet; a multiple-arch dam with a maximum height of 160 feet and a capacity of 240,000 acre-feet; a concrete arch diversion dam with a height of 28 feet; canals of a total length of 62 miles; a small earth-fill dam; a distribution system for 102,000 acres.

Power will be developed in seven plants.

The directors of the district are E. W. Michael, president, and J. D. Bowers and H. C. Ludden, John G. Bailhache is chief engineer for the district.



From cactus to canteloupes is the story of many irrigation projects in Arizona. An Armco ingot iron flume carrying water to the thirsty desert lands in the Southwest.



ARMCO



Culverts and Washing Machines

Did it ever occur to you that a washing machine has the same excuse for rusting that a culvert has? Both are subject to a succession of wet spells and dry spells and the alkali contained in soap and washing powders is duplicated by the alkali of the soil.

A number of leading washing machine manufacturers have adopted ARMCO Ingot Iron for the sheet metal parts of their machines, because its remarkable purity and evenness of texture make it highly rust resistant.

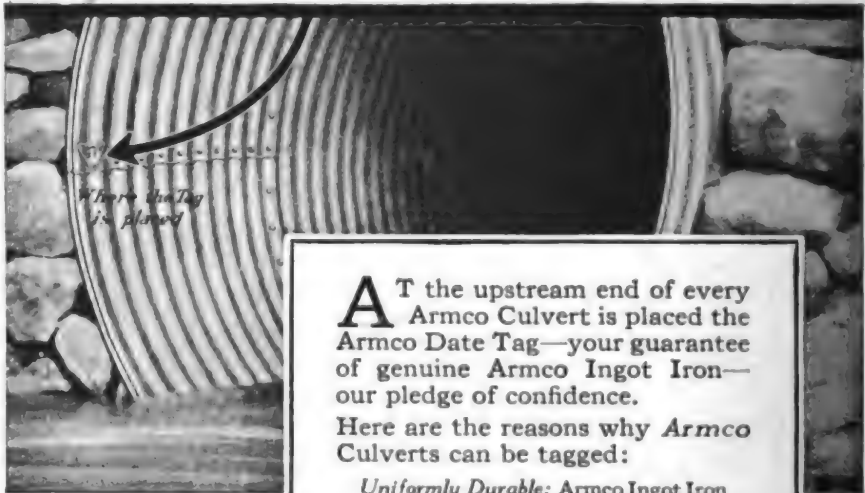
This fact should be significant to the highway engineer or constructor who wants rust-resisting culverts. May we send you the proof that ARMCO Ingot Iron *does* resist rust?



The American Rolling Mill Co.
Middletown, Ohio



Why ARMCO CULVERTS Can be Dated



AT the upstream end of every Armco Culvert is placed the Armco Date Tag—your guarantee of genuine Armco Ingot Iron—our pledge of confidence.

Here are the reasons why *Armco* Culverts can be tagged:

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The HIGHWAY MAGAZINE

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JANUARY
1924

"The Guardians of
Our Highways"
(See Page 9)

**Write to the nearest manufacturers for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

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Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

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The Dixie Culvert & Metal Co.

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Iowa, Des Moines
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Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
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Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

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Michigan, Bark River
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The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XIV

JANUARY, 1924

No. 12



The Columbia River Highway

The Columbia River Highway may truly be called the road to the tourists' paradise. The

accompanying photographs show the nature of the country traversed in the vicinity of Portland, Oregon, and the scenic wonders of forest, mountain, and river that await the tourist.





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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

The Sane and the Insane

THE advertising manager of a big daily newspaper, with his wife and two children, was touring one day last summer up in the mountains of Pennsylvania between Honesdale and Carbondale, when his car went dead on a hill overlooking the big Farview Asylum for the criminal insane.

He got out and tinkered with his car for awhile, but could do nothing, so he walked down and entered the grounds of the asylum, and seeing a big spick and span garage, went in and asked the man who seemed to be in charge if there was anyone around who could help him. The man said there was, they had a patient right there that was not only an expert auto mechanic, but also perfectly safe. He called him from the other end of the garage where he was working on a car and as he appeared to be a pleasant enough looking young chap, they both went back to the car.

It took the newspaper man but a few minutes to see that the man in the garage was telling the truth, because he went at the job in a business-like manner and in about a half hour had it fixed up in apple pie order. He then explained to the newspaper man what the trouble

was, how to prevent it in the future, and what to do if it happened again.

The advertising man asked the patient for his charges and he said five dollars, explaining that if the tourist went to a garage they would have an expert mechanic work on the car for a half day and perhaps charge more. He then said that while he did not like to boast, there were few, if any, men in the country who knew any more about the different makes of cars than he did, and that he loved to work on them and understood the mechanism thoroughly, but he would not ride in one for love or money, as he considered them too dangerous.

The advertising man was very much interested in the asylum inmate by this time and after he paid him asked him how it came that he was in such a place and if it was not possible for him to get released.

"Well," said the patient-mechanic, "you see I'm insane all right; I'm an expert at fixing cars, but I won't ride in them. I have hopes that the doctors will pronounce me sane some day, but in the meantime, I have free board, clothing and lodging in this beautiful institution, and make from fifty to one hundred dollars a week fixing up cars that go dead, break down, and sometimes get terribly wrecked here all along this road—cars that are owned and driven by people that are *sane*."

Uniformed Crossing Watchmen Command Respect

DUE to the flagrant disregard of the warning of crossing watchmen at Youngstown, Ohio, the Erie Railroad Co. has had its crossing watchmen appointed as a regular member of the police force of the city and properly uniformed as such. Under this new arrangement he has been able to demand the respect of automobile drivers on the highway the same as any traffic policeman with the result that there have been no more accidents due to disregard of his orders, nor have the crossing gates been broken as they occasionally were previously. The plan has been so successful that other railroad companies are now considering it for use in similar locations.

Snow-Removal Costs in Wisconsin

By N. M. Isabella,
Assistant Maintenance Engineer
Wisconsin Highway Commission

State Trunk Highway No. 15, Milwaukee County, showing drift where hand labor was necessary.

A LONG with the rapid growth of motor vehicle transportation come many other things which are made necessary, or are demanded by the users of the highway. Twenty years ago snow removal on a systematic basis was practically unheard of, and consequently highway transportation between small towns and between many of the larger cities during the winter was practically nil. How different it is today!

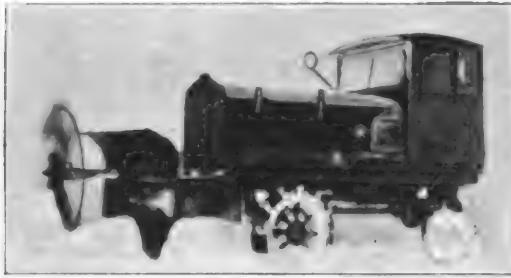
The great influx of motor vehicles during the past two decades has revolutionized highway transportation to a degree that many of the things being attempted and done today with motor vehicles would have seemed impossible a few years ago. Communication over highways in winter months is the common thing today. This is especially true in the well settled communities and in the localities where hard surfaced or so-called permanent roads have been built. One of the strong arguments for a hard surfaced road is that it is a 365-day a year road, and we find that the motor vehicle owner is gradually demanding that this type of road, especially, be kept open for travel the year round. He feels that an investment of from \$25,000 to

\$30,000 per mile should not lie idle during the winter months.

Wisconsin has at the present time about 1,700 miles of permanent or hard surfaced roads on its State Trunk and County Trunk Highway Systems. Keeping just this mileage of road free from snow during the winter months is no small task, to say nothing of the hundreds of miles of other important roads which have not been permanently paved.

Experience shows that the greatest impediment to travel in the winter is not the actual depth of the snow fall, but that it is the drifting of the snow which barricades the highway and forces traffic to a standstill. Probably one of the best plans of "snow drift removal" is "snow drift prevention." For several years past the Wisconsin Highway Commission, through its division offices and the county highway departments, has been conducting what is called "snow drift surveys."

In these surveys, the various highways were observed from time to time after snow fall, the exact places noted where drifts would form, and measurements taken of these drifts so that snow fences such as those shown in Fig. 2 would be



A rotary fan and belt outfit used by a Wisconsin county in keeping its highways cleared during the winter.

properly located the following winter.

Many miles of this fence have been erected in Wisconsin, and it has aided materially to keep the snow from drifting on to the highway. This plan works very well, but it does not solve the problem entirely, for when we get from one to two feet of snow in a single blizzard, as was experienced in March, 1923, other schemes must be worked out in order that the highway be put in service within a reasonable time after a heavy snow storm.

Wisconsin counties have been experimenting with many of the snow removal devices on the market today, and experience shows that there is still plenty of room for the development of a speedy, effective and economical snow removal device.

For the ordinary snow fall, the old plank "V" plow has in most cases been replaced by the blade grader. Many of the towns and villages are equipped with graders which are used in maintenance work during the summer, and they make use of them during the winter for removing snow from the highway. The counties, too, are all well equipped with graders of various sizes and types. Unfortunately, however, the grader has its limitations when used as a snow removal device. During the past winter some very interesting observations as to equipment, costs, etc., were made in counties in the southeastern part of the state.

The main highways in this part of the state are practically all hard surfaced and the demand for a clear highway in the winter is more pronounced here than in any other section of the state. The writer knows of no activity in connec-

tion with highway work wherein the cost of the work will fluctuate more than it will in snow removal. This, of course, is due to several reasons:

1. Snow fall is not uniform in all counties.

2. It will drift in some localities and not in others.

3. In some cases considerable hand labor is required, thus bringing up the cost of removal.

4. In some counties the snow is moved entirely off the highway from shoulder to shoulder and in others just a single track is cleared with occasional turn-outs.

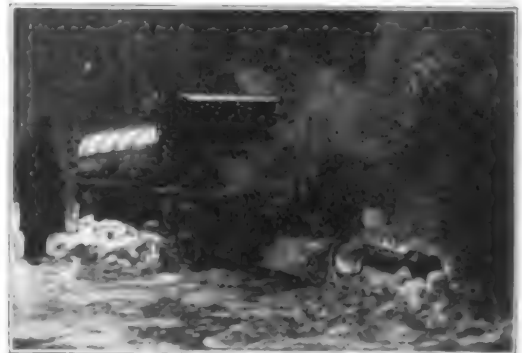
5. The type of equipment used in counties up to the present time has varied considerably. This is evidenced by the fact that many of the counties were using entirely different equipment at the close of the season than they started with in the beginning.

6. In some seasons the snow fall comes at intervals covering the entire period with no great snow fall at any one time and again we experience a season where the bulk of the snow fall comes during one or two heavy storms which completely paralyzes all traffic.

7. In many localities local aid is given and this is not always figured in the cost.

All the above mentioned items affect the cost of removal and it is easy to see why there might be a considerable variation in the cost per mile.

A few figures are given in Table No. 1 for some of the counties which carried



A snow-melting device used in New York City to clear the heavily traveled streets. It burns crude oil on the principle of the gas torch, and turns the snow into water almost immediately.

TABLE No. 2

County	Miles Kept Clear During Season	Paid by County	Cost per Mile	Remarks
Kenosha	18	\$ 5,000	\$280.00	Rotary plow on truck
Ozaukee	18	2,500	140.00	Blade plow on truck
Racine	44	7,000	160.00	Single blade plows on truck
Milwaukee	80	16,000	200.00	Single blade plow attached in front of truck and "V" plows attached to caterpillar tractors. Also hand labor



on systematic snow removal programs. The figures given are for a single storm which occurred on December 14, 1922. No drifting took place after the storm.

TABLE No. 1

County	Type of Equipment	Number in Use	Miles Cleared	Total Expended	Cost per Mile
Kenosha	Single blade plow on truck	1 with 2 men	15 (7' snow)	\$24.00	\$1.60
Milwaukee	Single blade plow on truck	8 with 24 men	80 (4' snow)	795.00	9.94
Racine	Single blade plow on truck	3 with 6 men	44 (8' snow)	92.98	2.11
Waukesha	Single blade plow on truck	2 with 4 men	32 (5' snow)	197.60	6.18

You will note that the cost per mile of snow removal for this particular storm varied from \$1.60 to \$9.94 per mile. These figures cover operating expense only. No depreciation of equipment or overhead expense is included. One reason for the Milwaukee County figures being somewhat higher than the average is due to the fact that they removed from shoulder to shoulder, whereas some of the other counties just cleared the traveled way.

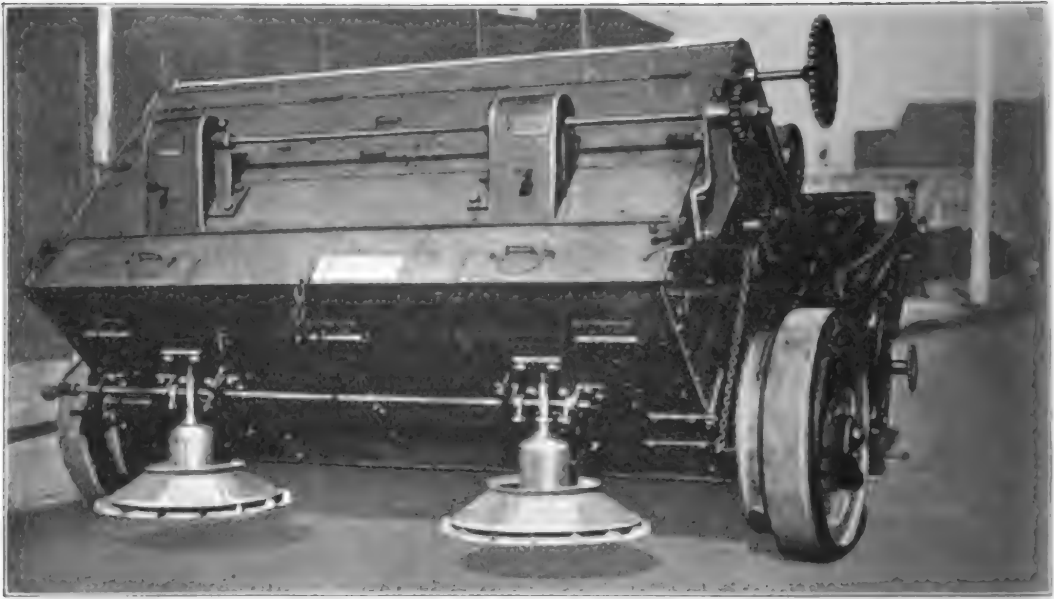
Table No. 2 shows the figures for the entire season for four typical counties. The funds expended by the counties are shown in Column 3. In some cases, however, there were some funds expended by local interests and by trucking companies, etc., which are not shown in this table. Therefore, the figures shown do not cover all expenditures but will serve to give the reader an idea of the approximate expenditure per mile per year.

Fig. 1 top, 6-foot "V" plow, 9 feet wide, attached to a caterpillar tractor, going through a 3-foot drift. Fig. 2 center, snow fences used for drift prevention. Fig. 3 right, a snow plow widening its first cut.



The matter of proper equipment is far from being settled in most of the counties. Some have tried the large blade grader, propelled by a caterpillar tractor and have found it quite satisfactory. Some counties have used the single blade plows pushed by a truck or tractor, and others have experimented with the rotary fan and belt outfits to advantage. Still others have tried the large 6-foot "V" plows, 9 feet wide, attached to a caterpillar tractor. This latter combination seems to be the most satisfactory when all conditions are taken into consideration. This outfit travelling 3 to 4 miles per hour had no difficulty in cutting through drifts as deep as five to six feet. Fig. 1 shows this plow going through a 3-foot drift with very little effort and Fig. 3 shows it widening its first cut.

In Milwaukee County it was demonstrated that this plow with two men going through snow two to four feet deep will clear an average of 12 miles per day at an average cost of about \$3.00 per mile for fuel and labor. Overhead and depreciation are not included.



A street sweeper converted into a sand spreader. By means of a coupling, the sand-spreading discs are quickly attached to the drive shaft operated by a drive chain.

Using Street Sweepers for Sand Spreaders

IN the Municipal Shops at San Francisco (which were built for the purpose of making repairs on motor cars and other equipment of the various city departments), two street sweeping machines have been equipped to be used as sand spreaders during wet and foggy weather.

These sweepers do excellent work, and have greatly increased the efficiency of

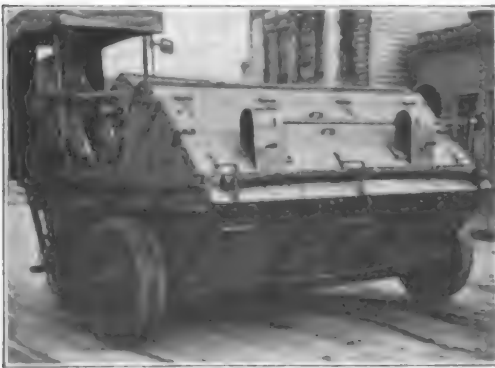
the street cleaning department, as they are now made to do double duty.

It has been the practice in the past to use the sweepers only during dry weather, but since being equipped with the sand spreading device, they are in constant use, sweeping the streets during the dry weather and sanding the streets during foggy and wet weather.

The superintendent of the street cleaning department made the alterations on the sweepers, which enables them to be converted into sand spreaders in a very short time, and vice versa.

A storage box carries the supply of sand that is to be spread on the street. Two specially constructed discharging discs are fastened to the front of the storage box in such a manner that the sand will feed into them by gravity.

The discharging discs are revolved rapidly by a chain drive. The spreaders are equipped with two speeds. The low speed will spread a path 12 feet wide, and the high speed will spread the sand over an area 20 feet wide. The box has a capacity of three yards, which will cover about 35 blocks, in two hours.



Showing sweeper used without sand-spreading attachment. Only 30 minutes are required to make the change in this double purpose machine.

Nevada's State-Owned and Operated Sand and Gravel Plant

The Lahontan Sand and Gravel Plant was constructed by the Nevada State Highway Department for the purpose of furnishing sand and gravel for various paving and road-building operations, as well as materials for concrete structures within a territory permitting freight haul.

NOTWITHSTANDING the fact that Nevada is probably the most mountainous of all the States, and there appears to be an ample supply of rock and sand everywhere, it is a fact that there are very few materials of this character which are suitable for highway construction.

In the early part of the spring of 1920 and after every other means was found infeasible, the State Highway Engineer was instructed to proceed with the construction of a sand and gravel plant at Lahontan, about 65 miles by rail from Reno. The supply at that point is located on the shore line of the Lahontan reservoir, and is the result of the formation of a delta in prehistoric times. The Lahontan Dam was constructed of this material, and considerable information was available from explorations



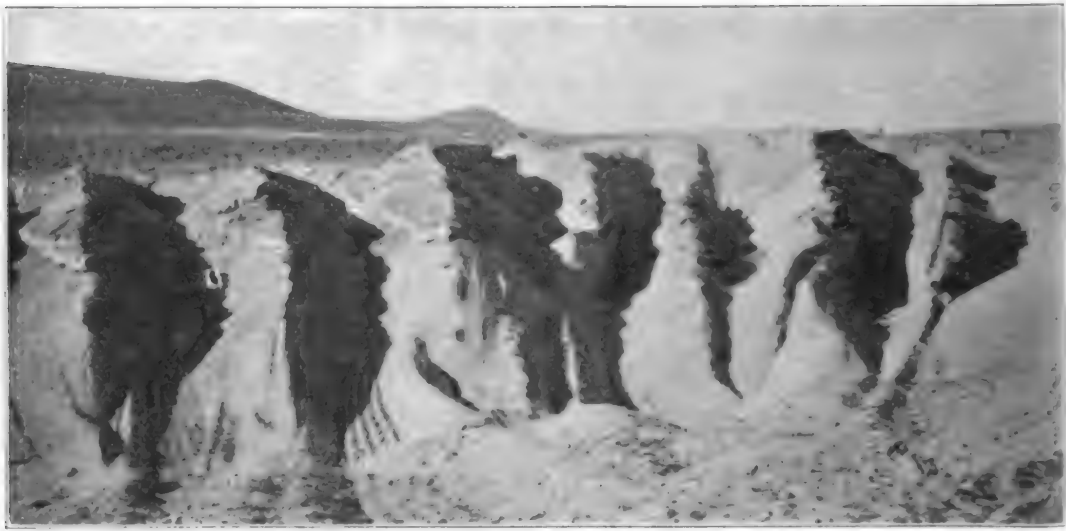
Cars loaded with sand and gravel ready for shipment from the Lahontan plant.

made by the Reclamation Service at that time, so that material that more than met the requirements as to quality was assured.

The plant had to be specially designed



A general view of the Lahontan Sand and Gravel Plant, constructed and operated by the Nevada State Highway Department.



The above photograph shows the trenches formed in removing the sand and gravel from the prehistoric delta formation which forms the source of supply.

for the particular material at hand, and consequently consists of some novel features. The plant is so arranged that the gravel is divided into three separate sizes and then remixed into a gravel for concrete construction. This has been found necessary in all parts of the country in order to secure gravel that will make the concrete of the required density, and consequently the most durable. After the gravel is separated from the material, sand is obtained by a washing process. Five bins constitute the superstructure, the first bin receiving the gravel which is in excess of $2\frac{1}{2}$ inches in diameter and is called the "oversize bin." One bin receives the gravel in sizes from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches; another from $\frac{3}{4}$ to $1\frac{1}{2}$ inches; another from $\frac{3}{8}$ to $\frac{3}{4}$ of an inch; the last being the sand bin. The bins altogether have a capacity of about twelve carloads.

The oversize rock obtained in the first bin is run through a crusher and re-delivered at the top of the plant and distributed to the various bins other than the one from which it came.

The three sizes of gravel are mixed in their proper proportion by means of a belt conveyor operating in a beltlike fashion from the back of the plant to the cars into which the material is loaded for shipment.

Water for washing the material is obtained from the Lahontan Reservoir, to which a large pipe-line was constructed. Electric power was obtained with which to run the plant itself, the pumps, and to give light. The plant was designed for a capacity of 700 tons in eight hours.

In the construction of this plant and its operation there has been a multiplicity of difficulties and hindrances. The machinery could not be purchased in the open market, and all had to be specially manufactured.

The total cost of the plant, excluding the spur-track, but including everything else, such as pumps, hoists, track lines, etc., was \$64,875.82, and originally paid for out of the State Highway Fund. The financing of this undertaking was such, however, that the Federal Government reimbursed the State to the extent of 50 per cent of the original cost, and Washoe County, to which the major portion of the material was shipped, will reimburse the State to the extent of probably 35 per cent of the original cost, dependent somewhat on the manner in which future projects in that county are to be financed.

The plant is a success, and the material coming from it more than meets expectations as to quality.

The Guardians of Our Highways

By PAUL THOMPSON

The tremendous increase in the mileage of hard surfaced roads throughout the country has witnessed an increase in the use of these highways by the lawless, both as a field of operation and the means of flight from justice. Eighteen states have solved the problem through the formation of State Police who patrol and guard our highways.

WITH the Royal Northwest Mounted Police and the Texas Rangers standing for all the fine and noble points of government in far country places, it is only a logical conclusion that every state in the Union should have its highway police force.

Eighteen states have already chalked up a record under the head of "State Police." A number of others are seriously moved to follow the example.

The separate units of the states working in co-operation with the Federal Government, have taken a long step in the direction of protecting the commonwealth, through patrolling the highways.

Why have we wonderful highways, if not as a means and an end to better living, better protection *while* we live?

Over hard surfaced highways an offi-

cer can respond with surprising quickness to a call for aid. If, in his judgment, a man appears guilty of a misdeed within the officer's cognizance, it is the latter's duty to arrest him. Thieves have little chance for escape.

In Colorado, the thing is down to an even finer point; all cars outside city limits are halted after midnight. It is not a case of the "innocent suffering with the guilty." The innocent recognize in the procedure a very sure protection. The guilty are bound to betray themselves.

Not long ago, the Illinois Bankers Association, meeting in Chicago, set forth a plan for the formation of State Police. County police, like the city force, are not enough for state protection.

The plan is a reproduction of that



New York state troopers disarming road bandits captured after a long chase in the vicinity of Troy, New York. These state troopers handle the big criminal problem in rural districts.

At right is shown a detachment of motorcycle mounted state police overhauling and arresting criminals who were using a high powered car and a hard surfaced highway as a means of making their getaway.



At the left in the circle, New York state troopers find police dogs their most valuable assistants. Here is one of the animals getting the scent from a criminal's shoe.

Lower left, the radio and the aeroplane have been successfully used by the St. Louis, Missouri, police in apprehending bandits. Photograph shows an aeroplane signalling the automobile and speed cops that a fleeing car has been sighted.

followed by the eighteen states above mentioned. In addition to the power of arrest, the police would co-operate with state and local authorities in enforcement of the fire, fish, game, forestry, public health, animal disease, and road and bridge laws.

Troops of this soldiery would be placed in the various state "zones," 65 men to a zone. The average patrol per man would be 40 miles, doubled at the end of the day. A superintendent stands above all these—above captains, lieutenants, corporals, etc.—with the shadow of Washington behind him.

And if, in New York state alone, the state police have returned \$560,000 above their upkeep during five years of existence, is it not the economic answer to the question of demanding, or not demanding the patrol?

And if, in Colorado, a call sent over the telephone can set a guard at every road in the state within an hour and ten minutes, is not the question of adequacy in emergency also answered?

Illinois has 717 small towns that are without police protection. The State Police would offer a means of protection while patrolling the state and county.

Departments of Public Protection see the advantage in improved highways. While horses might easily traverse comparatively ill-cared-for roads, the more frequently used motorcycle requires a smooth highway for its best performance.

And efficiency, being the keynote of the present-day body politic, "good roads" necessitates and makes possible State Police.



"In Colorado, all cars outside the city limits are halted after midnight. Automobilists find in this procedure a very sure protection rather than an inconvenience."



A battery of six 24-inch Armco ingot iron culverts installed on the Bend-Lakeview Highway, Lake County, Oregon.

Lake County, Oregon, Builds for Posterity

HOW many people visit a cemetery in a day?

How many people travel over a good highway in a day?

Those who visit a cemetery see the tombstones erected to the memory of their fellow citizens who have passed away.

Some men have monuments erected in public places in memory of the good they have done for their fellow men.

But not all tombstones are in cemeteries and not all monuments are in public squares. Some men build their own monuments, while others build what seems to be a monument but suffers the ravages of time and proves to be a tombstone rather than a monument.

If you were a road-builder, would you like to have a tombstone as your only memorial, or would you rather build your roads so that they would always be a monument to your good judgment and integrity, by which you helped your community and fellow citizens?

In the southern part of the State of Oregon is a county called Lake—a county rich in resources but geographically isolated.

Lake County's big industries are cattle and sheep raising. The ZX Ranch, in the Chewaukan country, run about 18,000 head of cattle. In the Warner Valley the MC run about 10,000 head of cattle, and the 7T run about 5,000 head. Two

million pounds of wool is shipped out of the county yearly.

There are fourteen billion feet of standing timber in the county, mostly yellow pine.

The southern part of the county bids fair to be a big dairy country, with thirty thousand acres on the west side of Goose Lake and fifteen thousand acres



"A former state highway engineer characterized the 60-inch Armco culvert at Warner Station, on the Bend-Lakeview Highway, as the best culvert installation in the state."



Left, "The masonry headwalls and Armco culverts make beautiful and durable, as well as efficient, drainage installations." Center, Roadmaster George Bentz standing by a 24-inch Armco ingot iron culvert installed in 1920, six miles north of Lakeview on the Bend-Lakeview Highway. Right, a section of one of the beautiful highways Lake County is building for posterity.

on the east side, all adaptable to raising alfalfa.

There are three irrigation projects in the county at present. The Goose Lake Valley Irrigation District in the southern part, and the Summer Lake and the Silver Lake in the northern part.

Up to a year ago there was not an all-year highway into the county and only a narrow-gauge railroad which comes up from Nevada. It runs north to Lakeview, the county seat, and goes out the same way it comes in.

But you can't keep a community of

live wires isolated. They are building permanent highways out of and through the county, and with their potential tonnage it seems certain that a trans-continental railroad will build thru the county.

The prime factors in Lake County's road building program have been Dr. E. H. Smith, County Judge, and George Bentz, County Roadmaster. These two men, with the aid of Commissioners A. D. Frakes and W. G. Lane, and the backing of the citizens, are building highways that will be a monument to them.

The foundation of every good highway is more drainage and better drainage. Lake County, in recognition of this fact, is using Armco ingot iron culverts for cross-road drains.

The culverts run from nine inches to sixty inches in diameter. A light-weight stone that weathers well is used for headwalls on practically all the installations. The masonry headwalls and Armco culverts make beautiful and durable installations. No better culvert installations can be found in the State of Oregon, and it is doubtful if there are any better in the United States. A former State Highway Engineer characterized the sixty-inch Armco culvert at Warner Station, on the Bend-Lakeview Highway, as the best culvert installation in the state.

In a sparsely settled and isolated community, such as Lake County, it takes initiative, good judgment, grit, hard work and sacrifice to build good roads. Lake County has a monument to testify that they had all these.



This is what happens to even a modern hard surfaced highway when mother earth becomes restless. Photograph shows an automobile road near Tokio, following the Japanese earthquake.



Irrigation and Drainage

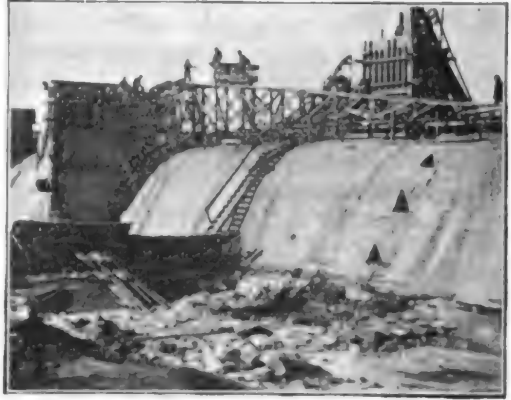
What the U. S. Reclamation Service Has Accomplished in Twenty Years

A brief resume of the work done in the arid regions of the west by the United States Reclamation Service proves the value of irrigation and points to a greater interest in the reclamation work of the future.

IRRIGATION possibilities in the West are still great. In the public domain alone, according to recent estimates made by the United States Reclamation Service, some 20,000,000 acres might be reclaimed, or more than ten times the area for which water has been provided by the Federal Government.

To all engineers and in fact to all taxpayers and citizens, there is a peculiar interest in the history of the U. S. Reclamation Service.

A review of the origin and development of the Reclamation Service is of importance at the present time not



Constructing the Wind River Diversion Dam—Wyoming's great irrigation project.



Downstream side of the Kerckhoff Dam, San Joaquin Light and Power Corporation, forty miles from Fresno, California. Fourteen Calco radial gates regulate the stream flow of the San Joaquin River.



Location of 26 government irrigation projects serving a total of 3,000,000 acres.

merely as a matter of history, but because citizens and taxpayers in various portions of the country are urging their representatives in Congress to adopt a broad national policy of land reclamation and settlement. This will involve expenditures of millions of dollars, not merely of federal funds, but of corporate and private moneys, in the creation of opportunities for more rural homes. A wise expenditure of these vast sums, which must be made as demands arise for more land, is dependent largely upon a full and correct knowledge of what has already been accomplished and particularly of the errors which should be avoided and of the mistakes which are inseparable with undertakings of this character unless careful study is given to similar undertakings.

At the time the Reclamation Act was signed—twenty-one years ago—conditions were far different than they are today; the ideas then prevalent are now seen to have been not only vague but not based upon full knowledge by Congress of the available facts.

Throughout the entire West there is more good land than there is water available for its reclamation. The choice, therefore, of areas to be reclaimed has been limited not so much by the char-

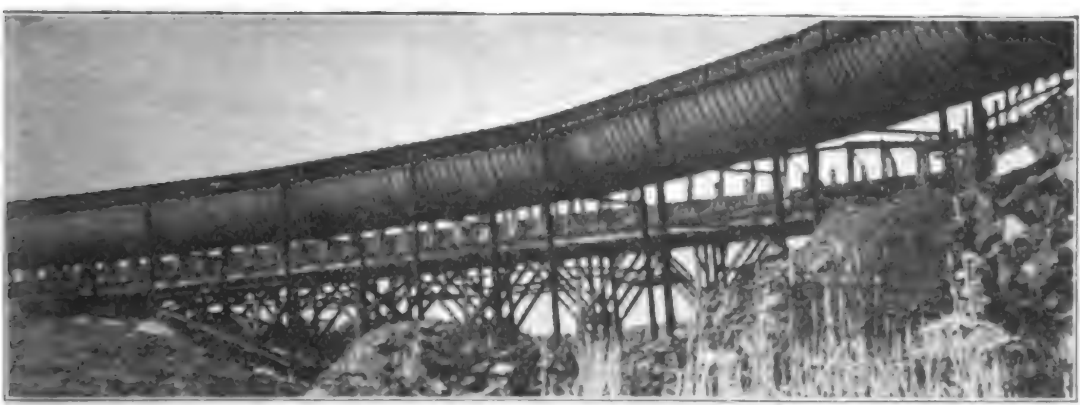
acter of the land as by the location of the water. This fact had been brought out by the earlier surveys.

During the past twenty years over \$140,000,000 of federal funds have been invested in building large works of reclamation, some of them monumental in character, all designed, however, with the ultimate object of providing opportunities for small self-supporting farm homes. The results attained in number of homes and in crops produced have exceeded the expectations of the advocates of the reclamation law. At the same time, however, there have been disappointments and failures, such as are inseparably connected with any human enterprise.

Briefly enumerated, the total amount of work achieved may be summed up in the following statement: that on 26 projects located as shown on the accompanying map, water can be served to 3,000,000 acres in round numbers, including from these projects, 1,700,000 acres for which the government systems furnish the sole supply for irrigation. Of this latter, 1,200,000 are actually harvested. The total number of irrigated farms is 33,000 and the population of these farms, 125,000. The gross annual crop is valued at \$50,000,000. The increase in value of lands and other properties on farms and in towns, within the projects is estimated at \$550,000,000. The



Intake end of 6700 feet of Armco ingot iron flume installed in the Cascade Irrigation District, near Ellensburg, Washington.



This Armco flume, with a capacity of 600 second feet of water, is installed on one of the largest irrigation projects in the state of Idaho. Note its substantial construction as compared with the old wooden flume shown in the background.

works as now constructed included 100 storage and diversion dams, reservoirs with a capacity of 10,000,000 acre-feet or storage, 4,000 miles of main line canals, and 8,000 miles of laterals or distributaries, 28 miles of tunnels, 140 miles of flumes, 9,100 bridges, and thousands of smaller structures.

From the purely engineering standpoint, there have been notable advances in methods and efficiency of construction. These have kept pace with the development of similar work elsewhere, since the operations under governmental control have been checked up continually against those handled by corporations or individuals. There has been a continual interchange of ideas, the government works have been visited at short intervals by engineers and experts from all parts of the world, incidentally contributing information or advice, as well as receiving inspiration for inaugurating similar works in other countries, and in other parts of the United States.

It is taken for granted that the federal government will continue to build, or at least to finance or help finance, the larger of the irrigation projects of the country. The Reclamation Service was created because of the conviction that the irrigation works awaiting construction were too large and the economic and human problems involved too many and complex for private enterprise, as they were also beyond the financial capacity of irrigation districts and even of entire

states. The irrigation works of the future will require still more capital and skill. Add, for instance, the cost of the huge Columbia River Basin Project to the minor projects that would press for simultaneous execution, and then increase all this by the settler's loans for lands, buildings, tools and livestock, already mentioned, and the total becomes so large as to make it patent that the future of irrigation in the United States is a subject demanding searching study by engineers, agriculturists, economists and statesmen.



A view of the famous Roosevelt Dam in Arizona. This is one of the largest and best known irrigation and power projects in the United States. The top of the dam serves as a main automobile highway for tourists through the southwest.



"An abandoned railway gully is being blocked by an earth fill to hold the backed-up waters of Dead River."

WHAT is considered by far the greatest engineering project of its kind ever attempted in the Great Lakes region, is in progress today on Dead River, Marquette County, in the Upper Peninsula of Michigan.

Here, at a point about ten miles from the mouth of Dead River, where it empties into Lake Superior, the Cleveland Cliffs Iron Company is constructing a huge, reinforced concrete dam, which will store up a water supply for generating power to be used in the above company's extensive mining operations along Marquette range.

The Cleveland Cliffs Iron Company operates a chain of iron mines in the district, from which it ships, over its own lines, a vast quantity of iron ore, annually. The mineral is loaded into cars at the mines and carried, first, to the huge iron ore dock at Marquette, declared by engineers to be the biggest all-steel and concrete freight dock in the world. The ore is loaded into the company's own freighters and thus shipped direct to the blast furnaces and steel plants in the lower Great Lakes region.

With the bulk of the concrete work already completed, some idea of the magnitude of the project is conveyed when it is considered that approximately 45,000 barrels of cement—comprising 42,000 yards of concrete—will have been used in the construction of this mam-

moth dam. The dam will measure 2,500 feet in length and sixty in height, at the highest point, and will have an estimated capacity of 2,000,000,000 cubic feet of water. The overflow or spillway section will measure 500 feet in length.

Another project, not as great, perhaps, as the concrete work, but a considerable task in itself, is nearing completion on the west bank of the river where an abandoned railway gully is being blocked by an earth fill, to prevent the backed-up waters of Dead River from overflowing that end of the dam.



This photograph shows the Cleveland Cliffs Dam under construction. When completed, it will have an estimated capacity of 2,000,000,000 cubic feet of water.

Feeding the Brute to Discover Its Habits



Snow-covered Testing Yards at ARMCO Plant

THIS picture shows the testing yards where we continually feed metal to the great iron-eater—rust.

Snow and rain, cold and heat—all the elements are given a chance to show their power of destruction on sheets of ARMCO Ingot Iron and other metals.

When the metal sheets have been there for months, the chemists and metallurgists examine sections under a powerful microscope. To an outsider, the difference in effect on ARMCO Ingot Iron and other irons would be a revelation.

The survival of ARMCO Ingot Iron is due to its purity. Foreign matter that invites rust has been eliminated during the special process of manufacture.

These testing yards and our extensive research laboratories are indications of the great, unceasing care taken to maintain the purity of ARMCO Ingot Iron. If you are a user of iron products where rust-resistance is required, write to us.



This triangular trademark on culverts, flumes, siphons, tanks, road signs, roofing, etc., is your assurance of quality and unequaled rust-resistance.

The American Rolling Mill Co.
MIDDLETOWN, OHIO

A Railroad Strength Test of ARMCO CULVERTS



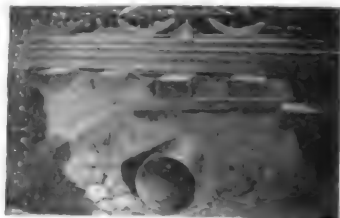
A 30 in., 12 ga. ARMCO Culvert, 14 ft. long supports a dead weight of 240,000 lbs. under railroad conditions at Annual Exposition of the National Railway Appliance Association.

THE illustration above shows the apparatus used. The pressure was applied by two 100-ton hydraulic jacks on two beams, simulating rails, placed on three standard wooden ties. A scant 12 in. of dry sand furnished the fill between ties and culvert.

The machine was designed for a load of 100 tons. Such a load showed no effect upon the culvert, and drawing on the factor of safety a load of 120 tons was imposed.

Even with this load there was no observable variation in the horizontal and vertical diameters of the pipe—no measurable deflection.

The condition of this test indicates a safety factor of approximately $2\frac{1}{2}$ over the normal railroad installation, definitely satisfying the engineers who witnessed the test that ARMCO



Under the main line tracks of one of the busiest railways in America—dozens of trains each day.

Culverts are amply strong for main track use. A 10-gauge pipe would greatly increase this safety factor.



Installations such as this are even a better test of the ability of ARMCO Culverts to meet railway requirements.



ARMCO CULVERTS

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The HIGHWAY MAGAZINE

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FEBRUARY
1924

"Building Roads in
America's Playgrounds"

See Page 15

***Write to the nearest manufactures for particulars
and prices on ARMCO Ingot
Iron Culverts***

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Idaho, Pocatello
The Burnham Mfg. Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equip. Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The Burnham Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Regina, Calgary, Vancouver, Vernon

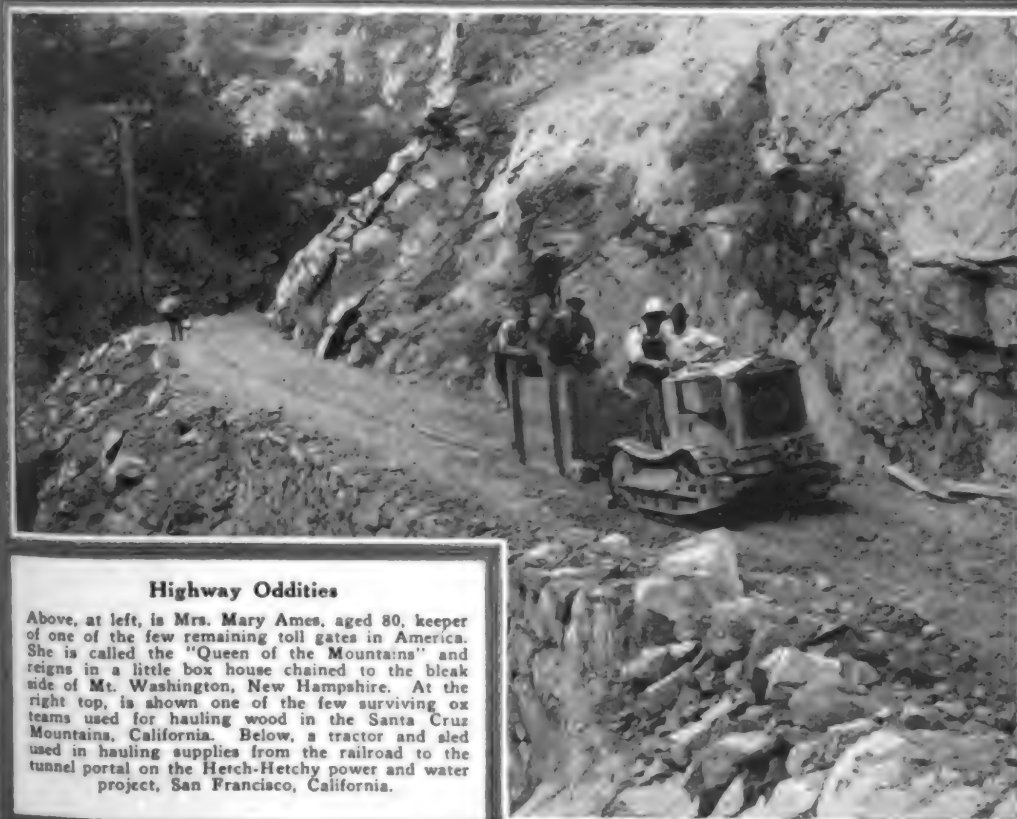
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VOL. XV.

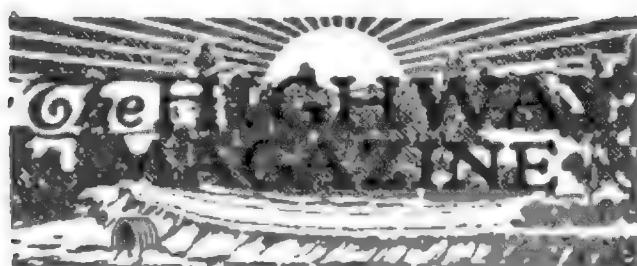
FEBRUARY, 1924

No. 1



Highway Oddities

Above, at left, is Mrs. Mary Ames, aged 80, keeper of one of the few remaining toll gates in America. She is called the "Queen of the Mountains" and reigns in a little box house chained to the bleak side of Mt. Washington, New Hampshire. At the right top, is shown one of the few surviving ox teams used for hauling wood in the Santa Cruz Mountains, California. Below, a tractor and sled used in hauling supplies from the railroad to the tunnel portal on the Hetch-Hetchy power and water project, San Francisco, California.



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LOUIS A. GRAHAM, M.E.....Consulting Editor

Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Washington and Oregon Bury "Old Man Detour"

ON the occasion of the Capitol-to-Capitol auto caravan, from Olympia, Washington, to Salem, Oregon, marking the completion of a 700-mile stretch of pavement on the Pacific Highway, from Vancouver, B. C., to the Oregon-California line, nearly a thousand automobiles took part in a joyous procession.

One of the many features of this unique celebration was a hearse bearing the lifeless body of "Old Man Detour" to his final resting place.

Clever sarcasm and sparkling wit enlivened the address made by Frank Branch Riley at the "funeral" of "Old Man Detour" at the Interstate bridge. The speech, in part, follows:

"Dearly Beloved:

"We are gathered together at last after years of eagerness and anticipation, to perform the last earthly rites over the muddy and crooked remains of one of the earliest inhabitants of this valley; a citizen well and unfavorably known to all of us—his neighbors—and the victims of his outlawry.

"There is so much that could be said of him that ought not be said! And so, mindful of the solemnity of this hour, and of the charity which should fill our hearts when the last farewells are said, to one whose life was as sweet to him as ours is to us, I am glad to give even this disreputable devil his due.

"He was an internationalist—as celebrated, as heartily discussed, and cussed, in British Columbia as in our own commonwealths. And though man's span of life is so evanescent, so

fraught with perils and so often broken, like a pitcher at the well, in the full tide of his activity, this old son-of-a-gun, afflicted as he was with sluggish circulation, with the creeping paralysis of pessimism, and in spite of the fact that for years there has been a price upon his disheveled head, he has lived to a ripe old age.

"Like us who are here today as happy mourners at these obsequies, Old Man Detour was a 'highwayman,' but he loathed the long smooth paved road with graceful curvatures and gentle grades. Rather, he lived in the byways, practicing his banditry on all wayfarers.

"We have known for some time that the old man was failing. His dreams of a kingdom of mud and narrow localism and provincialism were fading; his spirit was broken, he had outlived his time; the chums of his boyhood, the old horse and wagon, have long since gone into the vale of things forgotten. It may be that we have heaped unnecessary ignominy on the old man today. On his last journey we have speeded him over a boulevard that he loathed, here to the bank of the Columbia, the scene of his crowning achievement, for the wheezing Vancouver ferry of earlier days was his greatest triumph.

"Out upon this glorious bridge, which is anathema to him, we have conveyed him. And now, as a warning to all survivors of his kind, if any there be, in less happier commonwealths than ours, we consign to the welcoming waters of this majestic river Old Man Detour!

"He goes to a wetter and cooler place than is prepared for many of us! Peace be with him!"



"This old son-of-a-gun, afflicted as he was with sluggish circulation, with the creeping paralysis of pessimism, and in spite of the fact that for years there has been a price upon his disheveled head, he has lived to a ripe old age."

Improvements in Cook County Highway Paving By George A. Quinlan.

Supt. of Highways, Cook County, Illinois



"The best results have been obtained by having a central proportioning plant where the aggregates dry are proportioned."

COOK COUNTY, ILLINOIS, although the third largest county in population in the country, is the first in paved highway mileage. In December, 1922, the total was 291.2 miles of paved highway. The year 1923 saw this total carried well over the 300 mile mark.

In curing the 48 miles of concrete road completed in 1922, a calcium chloride treatment was used which we consider the outstanding feature in the development of road paving for the year. It has been found practical, efficient, and more economical than the practice of spreading a two inch layer of earth, which has to be kept wet for two weeks, entailing a considerable expense for labor, and it has been readily adopted by almost every road contractor in Cook County.

The calcium chloride is applied to the surface of the pavement at the rate of 3 lbs. to the square yard, and if no rain-storm occurs within 12 hours after the treatment is applied, no further application is necessary. In case of rain within the 12-hour period, the calcium chloride

must again be applied at the original rate.

Another advantage of calcium chloride treatment is that it can be applied even when the temperature is considerably below 35° Fahrenheit, provided the necessary precautions are taken to protect the pavement after it is laid.

Calcium chloride should not be used within 1,000 feet of any electric railroad, however, as a safe-guard against electrolysis.

A new road surfer which kneads the concrete instead of tamping it has been used on some of our recent work, and core tests taken show up most satisfactorily, proving the machine a practicable improvement over the tamping process. Its use permits the concrete to be mixed at a central mixing plant as far as seven miles from the scene of operations, and hauled wet, as the machine is supposed to operate as satisfactorily on stiff concrete as on a softer texture. In Cook County, however, the practice of having a central mixing plant where the concrete is mixed wet and then hauled by truck to



Major George A. Quinlan. Superintendent of Highways, Cook County, Illinois.

crete to be mixed at a central mixing plant as far as seven miles from the scene of operations, and hauled wet, as the machine is supposed to operate as satisfactorily on stiff concrete as on a softer texture. In Cook County, however, the practice of having a central mixing plant where the concrete is mixed wet and then hauled by truck to

the work has not been found practicable. The best results have been obtained by having a central proportioning plant where the aggregates dry are proportioned, and then hauled by truck to a concrete mixer on the grade, to be mixed and dumped directly at the work.

In Cook County, on Section 105, known as 47th Street, Chicago, a core drill investigation was carried on and excellent results obtained. In a distance of $\frac{3}{4}$ mile of pavement, the cores taken showed very favorable results. No core was below the specified thickness. In fact, all cores exceeded the specified thickness from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches, conclusively proving that the machine in use did not in any way disturb the crown in the pavement. The same condition prevailed in Section 78, which is known as the Northwest Highway, running into Barrington.

The gratifying feature of this investigation was that it showed the contour of the surface of the pavement was absolutely maintained, and the machine gave us a very satisfactory surface.

Without exception, tests on cores showed the concrete to be very dense. It is reasonable to believe that the tensile strength tests which are now being made will be satisfactory to all concerned.

In order to force the pavement to crack down the center rather than along the sides of the pavement, a corrugated metal strip is placed $\frac{1}{2}$ inch below the



The aggregates are hauled by truck to a concrete mixer on the grade, to be mixed and dumped directly at the job.

surface of the pavement and reinforced at 5-foot intervals with 4-foot bars $\frac{3}{8}$ inches in diameter. These bars are reinforcing bars. Along each edge of the pavement, for its entire length, a $\frac{3}{4}$ inch round painted bar is also placed in the pavement, allowing it to slide with the expansion and contraction of the sand.

In grading our ditches and shoulders, we always try to get them in a straight line. We insist that our contractors set stakes 6 feet from each edge of the pavement, insuring a straight line for the 6 feet of earth set up at the edge. A 1 to $1\frac{1}{2}$ slope is graded at the top of the slopes, where stakes are also placed, resulting in a pleasing alignment.

Shoulders and ditches are seeded, so that the roadways of Cook County make a delightful driveway for all who use them.

Wherever we pave over the structures the same year the fills are made, we reinforce all the fills. Fifteen feet is the maximum fill in this county.

The Northwest Highway has been created, but not paved. It is being allowed to settle, so as to insure satisfactory paving work. The extreme north section is completed, from the end of the Dundee Road pavement into the Village of Barr, and has been opened to traffic.



A section of Illinois road ready to be paved.

The World's Most Perfect Highway

By PERCY GOMERY

Past President, Vancouver Automobile Club
Author of "A Motor Scamper 'Cross Canada," Etc.

THE perfect highway is not yet. But there is a road from Vancouver, British Columbia, to Tia Juana, Mexico—The Pacific Highway—1725 miles long, which at this moment is 93.8 per cent perfect. There remain a round hundred miles in Siskiyou and Shasta, the extreme northern counties of California, to have concrete poured over its perfectly graded macadam surface, and then is achieved the *ne plus ultra* of roads.

The fact that this Pacific Highway brings the motor traveller within sight of about 6,500,000 of the 8,000,000 people dwelling on the Pacific coast; that it includes every type of scenery in the known world from an ant hill to the mighty ocean; that it has an unbroken line of luxurious hotels and a climate which keeps it open for an average of fifty weeks per year—these are considerations of interest to good roads enthusiasts the world over.

When was it built? How was it built? What was it built of? And how paid

for? These are questions of particular interest to highway constructionists.

In 1910, when the term "Pacific Highway" was first used, in a letter of Alderman A. E. Todd, of Victoria, to the Premier of British Columbia, there was not a yard of permanent highway outside the large cities of the Coast states. In September 1912 was completed the first unit of the Pacific Highway, south from the city limits of Vancouver, and, the following year, the 12 miles from that city to New Westminster on the Fraser river were completed. The first contract was bitulithic on concrete and the second asphaltic concrete on a concrete base, 22 feet wide with six-inch concrete curb throughout. This twelve miles remains today in a fine state of preservation.

It is significant that, on my recent end-to-end inspection of the Pacific Highway, I saw no other instance outside the cities of a curbed road.

The next record of paving was a contract for 5 miles just south of San Fran-



At the Oregon-California state line, on the Pacific Highway. The author's wife may be seen examining the surface of the pavement at the boundary intersection.

cisco in San Mateo County in August 1912, although the counties of San Diego, Santa Clara, Los Angeles and Sacramento had let contracts for another 27 miles within sixty days. And (reckoning on the common understanding that the Highway goes one way via the coast road and returning via the San Joaquin Valley) Stanislaus, Merced and Madera fell in line at exactly the same time by contracting for 51 miles. These earliest records in California were nearly all for 15-foot concrete base, oil surface.

No further permanent work was done on the British Columbia section until 1919-20 when five miles of one-course concrete were laid beyond the Fraser. In 1922 and 1923 the remaining 14 miles were laid at a uniform width of 18 feet to the International boundary at Blaine, the official opening of the Canadian section of 32 miles being on Labor Day last year.

On October 19, 1923, the Washington State section of 306 miles was completed and formally thrown open, following the

simultaneous completion of five contracts of seven miles each connecting the village of Toledo with Kalama, where the Pacific Highway joins the Columbia River.

All construction has been done by the State since 1917, the cost, on this road alone, during the six years being \$9,463,000, of which \$2,050,000 was federal aid funds. Much work had been done before 1917 by the counties; for example, King County (Seattle) had paved 14 miles and Pierce County (Tacoma) 26 miles (at a cost of \$20,000 a mile) in a variety of work including granitoid, asphalt, bitulithic and one course concrete, Lewis County (Chehalis) 17 miles (at a recorded cost of \$13,500 a mile of Warrenite and five brands of cement). Whatcom County (Bellingham) had built 10 miles of concrete, the slabs being divided by steel strips which, it may be of interest to note, have been a factor in destroying the surface at the joints during the road's life of seven to nine years.

Oregon's part is of interest in point of swiftness of construction. The State Highway Commission was organized in 1914 but, with the exception of a 5-mile strip of hard surface between the village of Central Point and Ashland near the southern border of the State, no work was done in the matter of paving until 1917. The length of the Highway across the State of Oregon is 345.6 miles, yet when I crossed it last year there was only one strip of 7 miles unpaved. In short, the State Highway Commission had paved 55 miles a year (on this one road) for six years in succession, at a cost of slightly over \$13,000,000.

The minimum width is 16 feet with 2-foot rock surfaces on each side. Maximum grades are five per cent, except in crossing the Siskiyou where six per cent has been allowed as a maximum.

Concerning the California section of this road, it has often been stated that California's earliest paved roads were crumbling under the traffic of a million motor vehicles a year, but the statement is made in the last Commission report that when these inadequate roads have been widened and thickened it is found that from 75 to 90 per cent of the original investment is salvaged.



Near the summit of Snoqualmie Pass, Washington, with plenty of snow on the mountainsides as late as June 1.



In the upper left hand corner may be seen adjacent sections of the old and new Pacific Highway through the Siskiyou Mountains. Upper right, a typical automobile ferry used in several places on the Columbia river. Lower left, a driveway through a giant Douglas fir in Northern Washington. Lower right, road near Halfmoon Bay, just outside of San Francisco, showing the sea in the background.

The Highway Commission is endeavoring to make the maximum weight of 30,000 lbs. permitted on the roads reduced to 22,000, and to enforce the law by the "Maryland Plan," whereby a truck caught overloaded is obliged to take off the surplus there and then, and stand the risk of loss and theft. The Commission quotes the maximum weight permitted elsewhere, in which Vermont appears as 12,500 and Michigan and New Jersey alone among the states which permit 30,000 lbs.

"The Battle of the Adobe" is an official phrase; seventy per cent of the paved roads in bad repair being found to be on adobe soil.

Convict labor has been used successfully on the California state roads. The cost in 1920-21 was \$2.06 per day as against \$5.50 free labor, and in 1922, \$2.30

as against \$4.50. Prison labor is never used where free labor is available.

The report sets forth that, owing to the enormously increasing traffic on the Pacific Highway, the road through the Sacramento canyon in the north is to be kept open all winter by snow-plows, and adds, "The development is of further importance inasmuch as, if the snow-plow proves a success, mountain roads may be routed over higher elevations at a saving of millions of dollars."

In this connection it is stated that the remaining work the Commission has set out to do is far more difficult in mountain sections. For example, the estimate for grading the Feather River road to only 12 to 14 feet is \$30,000 a mile, while grading and paving along the coast near San Juan Capistrano in Ventura County will be \$50,000 a mile.

A Bigger, Better Highway Magazine

THE present issue of *The Highway Magazine*, (Vol. XV No. 1) marks the beginning of this publication's fifteenth year of service in the highway field.

For the past fourteen years *The Highway Magazine* has been preaching the gospel of Good Roads in the United States and Canada. That it has carried the message with a fair degree of success to the constructionists, engineers and officials in the highway field is evidenced by the fact that the demand for it has steadily increased until at the present time it enjoys a circulation of more than a hundred thousand copies a month.

This circulation of more than a million a year greatly exceeds the circulation of any other monthly road magazine in America.

The editors of *The Highway Magazine* believe that this success is due to strict adherence to a policy based on TRUTH. Fact rather than fiction, purpose rather than prejudice, analysis rather than acceptance, has been the guiding spirit in selecting the material that goes into the pages of this publication every month.

Controversies, political or otherwise, have found no place in *The Highway Magazine*. The engineer with a story of actual achievement to tell will always find a ready mouth-piece in this publication.

It has been, and will continue to be, the aim of *The Highway Magazine* to give information based on the experience of Road Builders throughout the country, that may be used to advantage by its army of readers.

Highway Engineers and Officials, nationally known and recognized as authorities in their field, have been regular and frequent contributors to these pages.

The Editors are pleased to announce that beginning with this issue *The Highway Magazine* is increasing its size by the addition of four pages. This additional space enables the editors to present more material of vital interest to every one in the highway field and to present it in greater detail.

A Bigger and Better Highway Magazine will be the result. The same high standard of quality will be maintained, and the quantity will be materially increased.

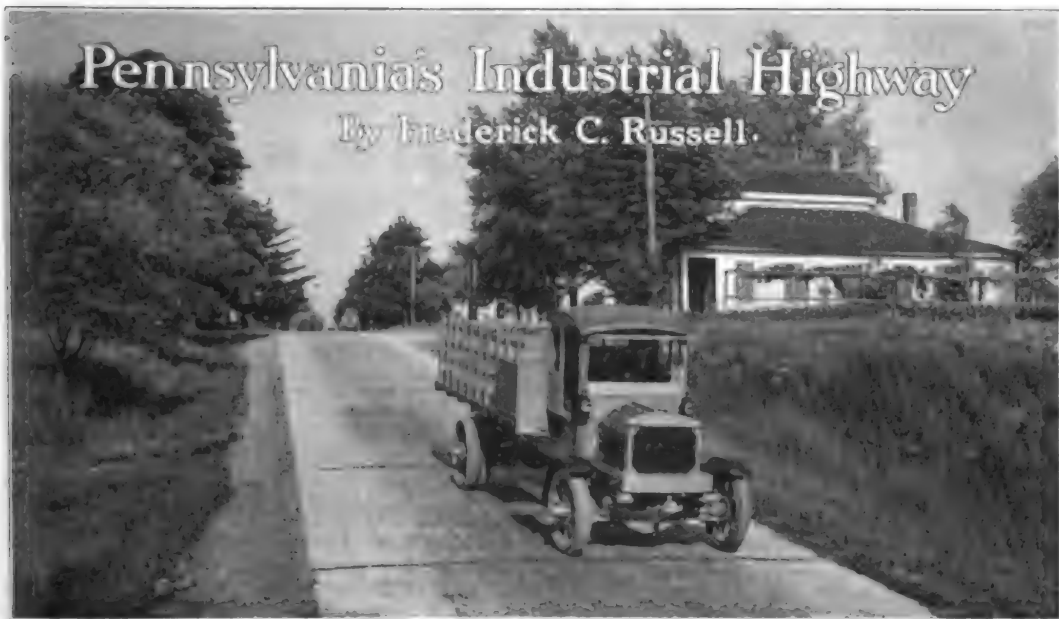
The Highway Magazine, one of the pioneers in its chosen field, will continue to point the way with greater service to the Highway Construction and Maintenance Men of America.



Contrast these former issues of the Highway Magazine of June 1912 and December 1918 with the present Bigger and Better Highway Magazine of 1924

Pennsylvania's Industrial Highway

By Frederick C. Russell



"The new highway is to be designated as the Industrial Highway and built with a view to handling the heavy type of commercial traffic."

WITH the enactment of a law providing for the survey, construction and maintenance of an industrial State highway between the cities of Chester and Philadelphia, Pa., the country will watch with keen interest the progress of a new trend in trunk line road building.

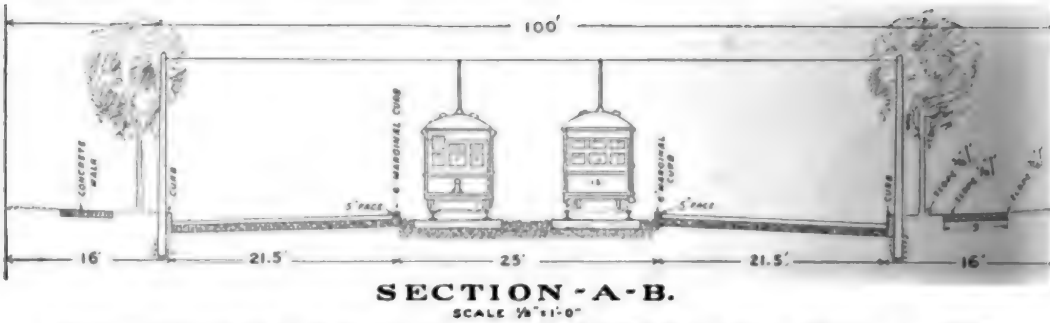
There has been considerable discussion over the question of the effect of motor truck transportation on the business of the steam roads, and a popular opinion is that the motor truck is not so well suited to inter-city haulage. The reason invariably given is the inadequacy of the average road for truck travel. The Pennsylvania experiment may, therefore, mark the beginning of a new attitude toward the truck and its long distance possibilities.

In fact, the highway is to be the direct result of a demand upon the part of a number of large manufacturing interests for an adequate line of way for heavy duty motor vehicles connecting these two industrial centers and the many factories between terminals. The bill is the direct result of the efforts of officials of the Baldwin Locomotive Works, West-

inghouse Electric & Manufacturing Co., Lester Piano Company, Sun Shipbuilding Co. and the Keystone Automobile Club, an affiliation of the National Motorists Association.

It was shown that the old Chester Pike was not only inadequate but unsafe for the volume of traffic passing over it, and the argument presented by the industrial leaders served to convince Governor Pinchot that an industrial highway would not merely solve a number of highway and traffic problems but stimulate the use of motor transportation units, thereby stimulating business.

The Act, presented in the Senate of the Pennsylvania Legislature in the session of 1923 as the "MacDade Bill," imposes certain very important powers and duties upon the Highway Commissioner. It is noted that the "State Highway Commissioner is hereby authorized to cause surveys to be made for a proposed industrial State Highway" and that, "Upon the completion of said survey, if an industrial highway as herein described and designated is in the judgment of the State Highway Commissioner justifiable, and if an equitable distribution of the



Cross-sectional plan of the proposed Industrial Highway from Chester to Philadelphia, Pa.

cost of construction and maintenance can be arrived at by the parties in interest, he is hereby authorized to take over such existing roads or private property as he shall designate for construction, reconstruction, improvement and maintenance of said industrial State highway."

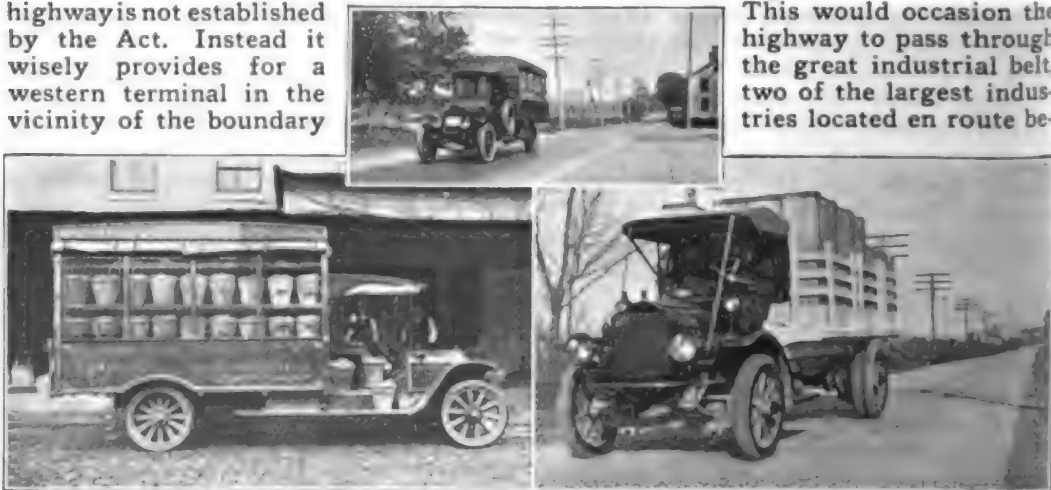
In other words, the Act specifically provides against rushing through a costly experiment. As Deputy Secretary of Highways and Engineering Executive, W. H. Connell, says, "This improvement will require, as you doubtless realize, considerable study. There are several bridges of size to be given consideration and the industrial establishments and the railroads in the territory lying between Chester and Philadelphia will play an important part in the decision as to the alignment and location of the highway."

The exact course of the highway is not established by the Act. Instead it wisely provides for a western terminal in the vicinity of the boundary

line of the City of Chester, an eastern terminal in the city line of the City of Philadelphia, and stipulates that it is to follow the shortest practical line between these two terminals, following the present public roads through the southern part of Delaware County as far as practical.

Although the old Chester Pike is about to be rebuilt, the industrial highway is not designed to be in any way a unit of it. Like the ill-fated proposal for an exclusive truck highway in Connecticut, paralleling the Boston Post Road between Bridgeport and Greenwich, the Pennsylvania highway will suggest some of the trends towards segregating local from express motor transportation.

The idea of the industrial highway is that it should be located as close to the Delaware River as possible, yet paralleling the Chester Pike. This would occasion the highway to pass through the great industrial belt, two of the largest industries located en route be-



An enormous increase in heavy motor truck traffic necessitates the construction of specially designed industrial highways.



At left is shown an unpaved highway finally abandoned after being destroyed by heavy motor traffic.



An idea of what a modern pavement has to withstand may be gained from the photograph at the left, which shows forty enormous tourist cars starting on a sightseeing tour in England. Above at right is shown a tractor ripping up destroyed pavement on one of Chicago's through streets.

ing the Baldwin Locomotive Works at Eddystone and the Westinghouse plant at Lester and Essington.

In paralleling the river the road will be practically free from grade, an important feature in industrial highway construction. And, in this connection, it is interesting to note another progressive touch in the offering of this Pennsylvania highway experiment.

While the new highway is to be designated as an industrial highway, and built with a view to handling the heaviest type of commercial traffic, it is understood that there is to be no effort to exclude other vehicles from it. Nor is it anticipated that the Chester or Baltimore Pikes will be closed to through truck traffic. On the contrary, the industrial highway seems to be planned with the idea that it will automatically attract both local and through truck and commercial traffic and that passenger cars will accordingly favor the older routes. The attitude is that, if this industrial highway is to be a success, it must segregate commercial from passenger traffic automatically and not be dependent upon additional legislation for its effectiveness.

The President of the Keystone Automobile Club believes that the highway will be completed within the next two

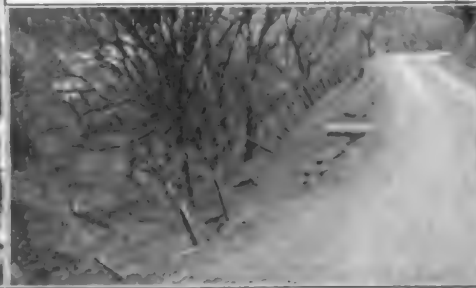
years, not merely for the reasons given but also because a large portion of the proposed course will represent an improvement of what is now known as the "Chester Short Line Road," because the highway will represent a great economy in that it will be the shortest possible route between the two cities and because many of the big property owners will contribute practically all of the land that is required, thus saving the Highway Department the expense of awarding damages which would otherwise be necessary.

The conclusion one must draw from the Pennsylvania experiment in highways is that the wholehearted support of the industries and property owners along the route proves beyond a doubt that an industrial highway is a necessity. This necessity, moreover, cannot possibly be confined to the industrial belt lying between two adjacent cities in one section of one state.

That is why roadbuilders, traffic experts and the public will watch the development of the industrial highway with great interest, keenly anticipating an era in which the road building programs of the country at large will recognize the importance of developing paralleling industrial and passenger trunk lines.

Wooden Culverts and the Fire Menace

By PAUL THOMPSON



Three Armco ingot iron culverts which successfully withstood the ravages of fire in Berkeley's devastated area. At the left is shown a part circle culvert at a street intersection. In the center may be seen another undamaged Armco culvert in the heart of the burned district of Wildcat Canyon Road. At the right is another unharmed culvert surrounded by debris on the Wildcat Canyon Road.

EVERYBODY has read of the great Berkeley, California, fire on September 17 that, rushing down from the wooded hills before a driving Northeast wind, destroyed within two or three hours over six hundred residences and laid waste one of the most beautiful sections of the city. Morals of many kinds are being deduced from the disaster and its causes: New sixteen-inch water mains will be installed in the hill districts, a police patrol through the fields and woods on the East of the town will supplement the efforts of property owners to extinguish small blazes which would otherwise become menacing, and wooden shingles for the roofs of houses have been placed under the ban by the City Council.

One phase of the occurrence, however, which is of great importance to street and road builders, has not thus far been given publicity. This is the menace to property and even to human lives involved in the use of wooden bridges and culverts.

A few years ago, in a great forest fire which raged through the lumber regions of Michigan, many wooden bridges and culverts were destroyed, and in some instances, the chasms thus produced in the

roadways brought about the wrecking of automobiles which were being operated in rescue work and resulted in the deaths of several of the refugees. Fortunately, no lives were lost in the Berkeley fire, but the ruins afford many examples of the folly of installing culverts made of so temporary and inflammable a material as lumber. The streets of Berkeley still afford many examples of plank box culverts which were placed to carry surface drainage across street intersections. By dint of frequent repairs and replacements they serve the purpose fairly well until a more lasting construction can be substituted, but when the buildings or even grass and bushes near them are destroyed by fire, it often happens that they burn out more or less completely and allow the pavement above them to collapse. Instances of this are shown in the accompanying photographs. These break-downs, of course, constituted serious obstacles to the fire apparatus and to vehicles employed in salvage and rescue work.

On the other hand, a great many part circle culverts of corrugated Armco Iron are employed in Berkeley at street and railroad crossings, both in the burned-out district and in other sections. None

of these suffered from the conflagration.

Still more striking is the contrast between burnable and unburnable culverts which is to be seen on Wild Cat Canyon Road. This is an ordinary earth highway which runs through the wooded valley on the easterly side of the Berkeley hills.

It was in Wild Cat Canyon that the fire originated; and it raged furiously across the ravine and up the wooded slopes toward the city. Numerous small water courses, most of which were dry at the time of the fire, were provided with culverts at the points where they intersected the road, these culverts being either of corrugated iron or of red-wood planks. So far as can be observed, all of the wooden culverts in the path of the fire were destroyed. In some locations the compacted earth above them managed to retain its position, but in others, it collapsed, forming extremely dangerous holes in the roadway. The corrugated culverts, on the other hand, were practically undamaged, though in some cases, their wooden headwalls were completely destroyed. The burned-out culverts are now being replaced with corrugated pipe.

Preliminary Work on Forest Highway in Arizona Approved

EXPENDITURES totaling \$70,000 of national forest highway funds for the construction of drainage structures in connection with the improvement of a road through the Coconino National forest of Arizona have been approved by Secretary of Agriculture Wallace. This money was made available for roads serving the national forests and for roads within or adjacent to the forests which are of primary importance to the state, counties, and communities.

The proposed work on drainage structures is a preliminary step in the improvement of the Flagstaff-Angel road through the Coconino forest. The project embraces nearly 24 miles of highway with Flagstaff as its western terminus.

The road in question is part of one of the main east and west highways through Arizona, and its improvement will be of great value not only in the administrative and protective work connected with the Coconino forest but to the public as well.



What happened when fire destroyed the wooden culverts under Berkeley's streets and roads last September. Street pavements and road surfaces were destroyed in the vicinity of burned-out wooden culverts.

Is the Horse Coming Back?

The enormous increase in motor transportation throughout the United States would naturally lead one to assume that the horse industry is on the wane. Statistics show, however, that such is not the case, as there is still a strong demand for horses and mules.

THE horse obsolete? Not according to recent figures compiled by Professor E. V. Collins of the Iowa College of Agriculture.

The Professor has perfected an instrument called the dynamometer. It is one of those things that is bound to "revolutionize" something. In this case it is the draft horse and mule industry.

Experiments conducted by the inventor brought out a number of interesting facts.

The size of a load a team can pull depends upon the road—the same team can draw three tons on a concrete pavement easier than one ton on a firm dirt road;

Teams developing 2,300 pounds tractive or drawing pull, can pull a 24-ton load over a level pavement and 66 tons after they have once started;

Tested teams show all the way from 8.6 to 21.2 horse power, exerting from 2,000 to 2,300 pounds tractive pull;

Heavier teams surpass the lighter ones, starting loads with less exhaustion and taking them easier and more quickly to their destinations.

Here is another argument—and a telling one—for good roads. Consider the conservation of energy in the use of a smooth pavement; consider the loss of time and energy involved in the use of poor roads.

It is only one angle of the road problem; but it touches keenly upon a subject of paramount importance.

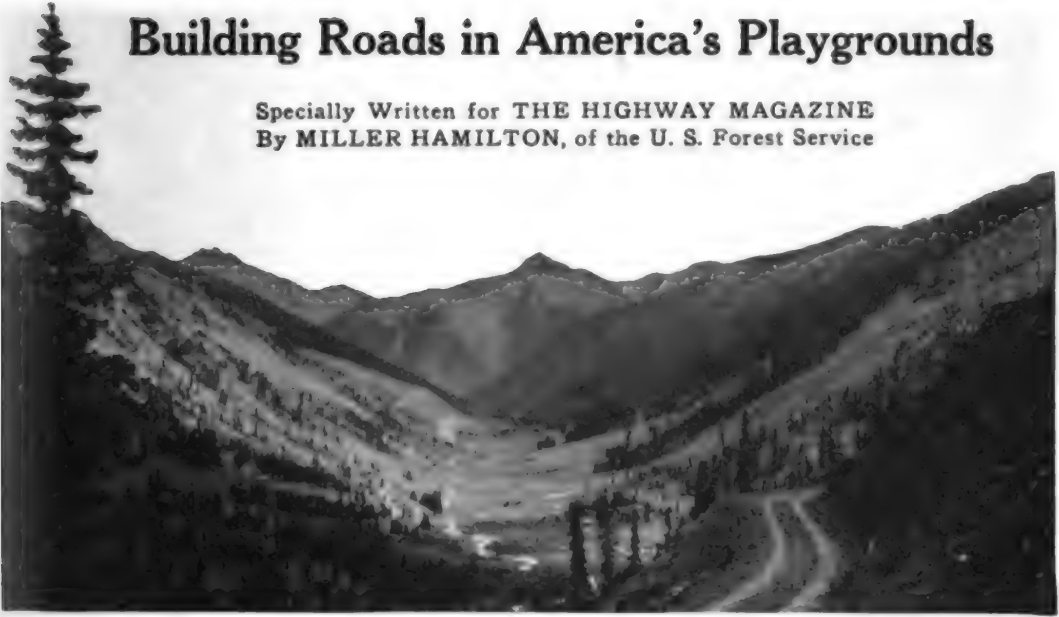
The Professor's invention makes possible a new outlook for constructive breeders who have realized that selection on a basis of performance is the only sure and certain method of improving the draft qualities of horses and mules. Following a series of tests made by the inventor, it was taken as evidence that permanent highways are bigger time and money savers for farmers than previously estimated.



Horses are still a vital factor in the transportation problems of the United States and Canada. In the above photograph a 12-horse freight outfit may be seen making a complete turn in a 55-foot circle, at Weaverville, California.

Building Roads in America's Playgrounds

Specially Written for THE HIGHWAY MAGAZINE
By MILLER HAMILTON, of the U. S. Forest Service



Looking down Mineral Creek from the Ouray-Silverton Road in the Uncompahgre National Forest, Colorado.

FROM January 1, 1922, to June 30, 1923, greater progress was made in road and trail work on the National Forests than in any preceding period of the same length. During the fiscal year ended June 30, 1923, 2,024 miles of roads and 4,123 miles of trails were constructed. This work brought the grand total for all years up to 6,873 miles of roads and 10,675 miles of trails. The mileage of roads maintained was brought up to 7,243, and the mileage of trails maintained was increased to 29,078.

The total amount apart from the National Forest road funds for road and trail construction and maintenance up to June 30, 1923, stands at \$32,714,862. Of this total, Federal funds supplied \$24,559,019, and the balance, \$8,155,843, came from States, Counties, and private organizations on a co-operative basis.

According to estimates by the United States Forest Service, about \$14,278,000 will be spent on forest roads and trails during the current fiscal year, and the estimated expenditures for this fiscal year and the fiscal year ending June 30, 1925, are estimated at around \$25,000,000.

Plans prepared by the Forest Service provide for a system comprising 35,330

miles of road and 36,279 miles of trail. The number of years it will take to complete this program is, of course, problematical, depending as it does on Congressional appropriations, co-operative funds from States and Counties, and receipts from the National Forests themselves. In this connection it is not generally known that 10 per cent of receipts from sales of timber, livestock grazing permits, and other uses of the National Forests is expended for forest roads and trails. In addition, 25 per cent of the forest receipts are turned back to counties within which National Forest areas lie for county school and road funds.

The Forest Service keeps in mind the recreational advantages of the National Forests and has constructed many roads within recent years which have opened up great areas to motorists. The Forest Service is extending its road and trail building operations in the forests of the Southern Appalachian Mountains, where highway improvements will aid greatly in making these regions accessible to vacation seekers.

Main roads within the National Forests are built as part of and to connect with main traveled highways which



Good roads and trails through our National Forests have served to popularize the auto tourist camp, such as the Rocky Mountain Lake Auto Camping Grounds, at Denver, Colorado, shown above.

usually lead from one important community to another. The Forest Service and the Bureau of Public Roads co-operate to the fullest extent with all State Highway Commissions in constructing roads that augment and connect with main State highways.

All major road projects are carried out in co-operation with the Bureau of Public Roads, which handles the actual construction work on such projects, while minor road projects and trails are handled direct by officers of the Forest Service. Camp sites and sign posts are two other phases of road and trail build-

ing in the forests on which the Forest Service is spending funds.

The extent to which the 147 National Forests, embracing 157,000,000 acres, are being used by the public as vacation grounds is brought out forcibly by the increase each year in the number of visitors to these forests. In 1917 the visitors numbered 3,160,300, while in 1922 this number had doubled, reaching 6,172,942. All indications point to a continued increase for the years to come as the recreational advantages of the Na-

tional Forests become better known to their owners—the American public.

Below is a view of Lookout Road near Denver, Colorado.



A section of the Cochetopa Pass Road, Colorado, built by the U. S. Forest Service



Above, an auto caravan on the Pikes Peak auto highway near Glen Cove, Colorado, Pike National Forest.





Drainage Operations on the Palo Verde Irrigation District



Three or four feet of water seeped into the Palo Verde drainage ditch while the work was in progress, showing the urgent need for drainage.

AT Palo Verde, California, as on so many other notable irrigation developments, extensive drainage operations have been found necessary in order to keep the water table at the proper level. A great drainage ditch was decided upon and F. F. Friend, the District Engineer, worked out the details early in 1923. A contract was let to D. A. Foley and Company which involved the excavation of approximately 40,000 cubic yards of earth and the other operations necessary to the construction of an adequate drainage ditch.

The Foley Company sublet the work to P. B. Engh and Mr. Engh has carried it to a successful conclusion. Two-and-a-half-yard Paige Dragline Excavators

were employed and the work was handled in three shifts of eight hours each, the excavators being stopped only



A drag line excavator at work on the Palo Verde irrigation district drainage project.



One of the several Armco flumes installed on the Palo Verde project to carry irrigation water over the drainage ditch, as described below.

when it was necessary to overhaul them. In spite of the large scale of the project, no unusual difficulties were encountered, and the big ditch is now in full operation. One of the photographs shows that even before it was completed, drainage water had seeped into it to a depth of three or four feet, which fact clearly shows the urgent necessity for the work.

The engineering problems consisted in providing for the intersections of the new drainage ditch with the irrigation canals. In some locations the drainage ditch was carried beneath the irrigation waterways by means of Armco corrugated pipes 48 inches in diameter. One of these under the D-10 canal is 66 feet long and another under the main canal is 102 feet long.

In other places the topography made it simpler to make provisions for these intersections by carrying the irrigation

water over the drainage ditch by means of metal flumes. On one of these locations 102 feet of No. 72 Armco flume was employed; in another 334 feet of No. 84 was used; and in a third, 387 feet of No. 96 flume was installed. All of these flumes were erected without difficulty and without any delay to the main construction operations. Ten bridges were built by the Mercereau Bridge and Construction Company as sub-contractor for the bridge work.

Mr Howard Foley is Superintendent for Contractor Engh and was in direct charge of these operations. The improvement abolishes the danger of water-logging, and has materially raised the value of all the land in the District.

—Continued—

Michigan to Complete Famous Chicago-Straits Route

MICHIGAN recently made a \$2,500,000 gift to the nation's pleasure seekers when the state administrative board authorized the building, by the end of 1924, of 84 miles of pavement on the historic West Michigan Pike (M-11), from a point near Pentwater, north of Muskegon, to Traverse City.

The Pike, which starts at Chicago, circles the southern end of Lake Michigan through the Indiana dune country and follows the eastern shore of the lake through West Michigan to Mackinac City, the tip of the lower Michigan peninsula. It is over this highway, which is 472 miles long, that thousands of tourists pass each season.



Another view of the ditching operations necessary to the successful irrigation of the Palo Verde District.

Malone Diversion Dam Completed

This new structure, costing approximately \$87,000, will divert water for irrigation of 10,000 acres of Oregon land. Water will be turned into West Canal with the opening of the irrigation season of 1924.

ON the Klamath project, Oregon-California, Government forces have recently completed the construction of Malone Diversion Dam. The dam is located on Lost River, about 10 miles below Clear Lake Reservoir and about 45 miles southeasterly from the city of Klamath Falls, Oregon. The construction of the dam is part of the plan for the irrigation of about 5,800 acres on the west side of Langell Valley and about 4,300 acres in the vicinity of Bonanza, Oregon. Stored water will be released into Lost River from Clear Lake Reservoir and diverted from the west canal at Malone Dam.

The diversion dam consists of an earth embankment with a spillway and canal head-gate structure located on the west side of the river; there is also a small head-gate on the east side. The earth embankment is 400 feet long. Its maximum height is 32 feet, the upstream slope is 3 to 1, and the downstream slope 2 to 1. The capacity of the spillway is 4,000 cubic feet per second. The dam will raise the water surface about 18 feet



A typical melon field on the rich irrigated Umatilla homestead project, Umatilla, Oregon.

above normal. On the west side of the river the foundation consists of lava bedrock; near the center of the channel the bedrock dips downward. The eastern half of the river channel was underlaid with lava boulders and gravel mixed with clay, ash, and cinders. East



The Malone Diversion Dam will divert water for irrigating 10,000 acres of Oregon land. Stored water will be released into Lost River from the Clear Lake reservoir and diverted from the West Canal at Malone Dam.



A section of Armco ingot iron rust resisting watertight flume, carrying water to the irrigation project of the Capay Valley Ditch Company, Yolo County, California.

of the river bed the above materials were covered to a depth of about 6 feet with a black mucky material, which was composed largely of vegetable matter; this was removed before placing the material for the embankment. The principal quantities are: Embankment, 18,500 cubic yards; reinforced concrete, 452 cubic yards; and riprap, 1,732 cubic yards. The work was begun in July, 1922, and completed in May, 1923.

The water at the site was about 8 feet deep. Cofferdams consisting of juniper trees and earth were constructed above and below the dam site. The river water was by-passed through a small flume; the flow amounted to only a few cubic feet per second. Little difficulty was experienced in removing the water between the cofferdams. The excavation of the mucky material in the river bed was done with a stiff-leg derrick operating a clamshell bucket.

In building the embankment about 3,500 cubic yards were placed with fresno scrapers and 15,000 cubic yards with dump wagons.

The channel leading to the spillway structure was paved with a grouted pav-

ing. The upstream face of the dam is protected with riprap 18 inches in thickness. The downstream side is protected with riprap about halfway up; the upper half of the downstream face is protected with large sized crushed rock.

Rock for concrete was crushed on the job. Rock for the crusher and for riprap and paving was obtained from two quarries, one about 200 feet and one about 2,000 feet from the dam. Sand was shipped in from Marysville, California. The sand, cement, reinforcing steel, metal work, timber, all equipment, and supplies were hauled in by motor truck from Dairy, Oregon, a distance of about 27 miles. Contract hauling was at the rate of 23 to 30 cents per ton-mile.

Common labor was paid \$3.00 to \$4.50 per day; more-skilled labor, \$4.50 to \$5; carpenters, \$7. Horses were rented at \$20 each per month, the United States furnishing subsistence.

The job was always short of men and the turnover was high.

It is expected that water will be regularly diverted into the west canal with the opening of the irrigation season of 1924.

ARMCO INGOT IRON

TRADE MARK
FOR ENAMELED PRODUCTS



The Beauty of Fine Porcelain with the Strength of Iron

Look for this Blue and Gold Armco Label on Washing Machines, Stoves, Ranges, Refrigerators, Enamel Table Tops and other household & commercial utilities. It carries with it the assurance of the quality and solid worth of the sheet metal parts of articles that bear it.



A refrigerator of enameled "Armco" Ingot Iron has the sheer, beautiful gloss of fine porcelain. The surface is smooth and unbroken by "pin-holes," bubbles, or lumps.

This is due to the purity of the iron base. By special processes of manufacture, "Armco" Ingot Iron sheets are purified of foreign matter that is found in all iron ore and in the other metals used. Thus the tiny atoms of iron

are closer together, the texture is uniform, and the enameling grips with the maximum adherence. There is no tendency of the enamel to split, crack, or flake.

When buying a refrigerator, a stove, a washing machine, or an enameled table top, ask the salesman if it is made from "Armco" Ingot Iron. Look for the blue and gold Armco triangle, which manufacturers are glad to place upon such products.

Write for Needed Information

The American Rolling Mill Company
MIDDLETOWN, OHIO



Just a few hundredths difference

Analysis shows only a few hundredths per cent difference between ARMCO Ingot Iron and substitute culvert materials.

Analysis shows only a few hundredths per cent difference between the hard vanadium steel gears of your car and the soft, mild steel of its body sheets.

How long would your car last if the manufacturer had not considered a few hundredths per cent worth his notice?

A large graphic for ARMCO Culverts. It features a large triangle on the left containing text about the purity and durability of ARMCO Culverts. To the right of the triangle is a faint, grayscale image of a culvert. Below the triangle, the words "ARMCO CULVERTS" are written in large, bold, capital letters, underlined.

Highest Uniform Purity

ARMCO Culverts are made of the purest commercial steel produced—by far the most uniform culvert material in the world. They have been given longer tests, under more widely varying conditions than any other corrugated culverts.

No other culverts of any material can give you such positive assurance of durability—money's worth—satisfaction.

ARMCO CULVERTS

The HIGHWAY MAGAZINE

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1924

"Demonstrating
the Improvement of
Earth Roads"

(See Page 15)

**Write to the nearest manufactures for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock The Dixie Culvert & Metal Co.	Nebraska, Wahoo Nebraska Culvert & Mfg. Co.
California, Los Angeles California Corrugated Culvert Co.	New Hampshire, Nashua North-East Metal Culvert Co.
California, West Berkeley California Corrugated Culvert Co.	New York, Albany North-East Metal Culvert Co.
Colorado, Denver The R. Hardesty Mfg. Co.	New York, Elmira Highway Products & Mfg. Co.
Florida, Jacksonville The Dixie Culvert & Metal Co.	North Dakota, Wahpeton Northwestern Sheet & Iron Works
Georgia, Atlanta The Dixie Culvert & Metal Co.	Ohio, Middletown The American Rolling Mill Co. The Ohio Corrugated Culvert Co.
Idaho, Pocatello The Burnham Mfg. Co.	Oklahoma, Oklahoma City The Boardman Co.
Indiana, Crawfordsville The W. Q. O'Neill Co.	Oregon, Portland Coast Culvert & Flume Co.
Iowa, Des Moines Iowa Pure Iron Co.	South Dakota, Sioux Falls Sioux Falls Metal Culvert Co.
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Maryland, Baltimore (Munsey Bldg.) The Maryland Culvert & Metal Co.	Texas, Houston Western Metal Mfg. Co.
Massachusetts, Palmer New England Metal Culvert Co.	Utah, Woods Cross The Burnham Mfg. Co.
Michigan, Bark River Bark River Bridge & Culvert Co.	Virginia, Roanoke Virginia Metal Mfg. Co., Inc.
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Canada

Canada Ingot Iron Co., Ltd.

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The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

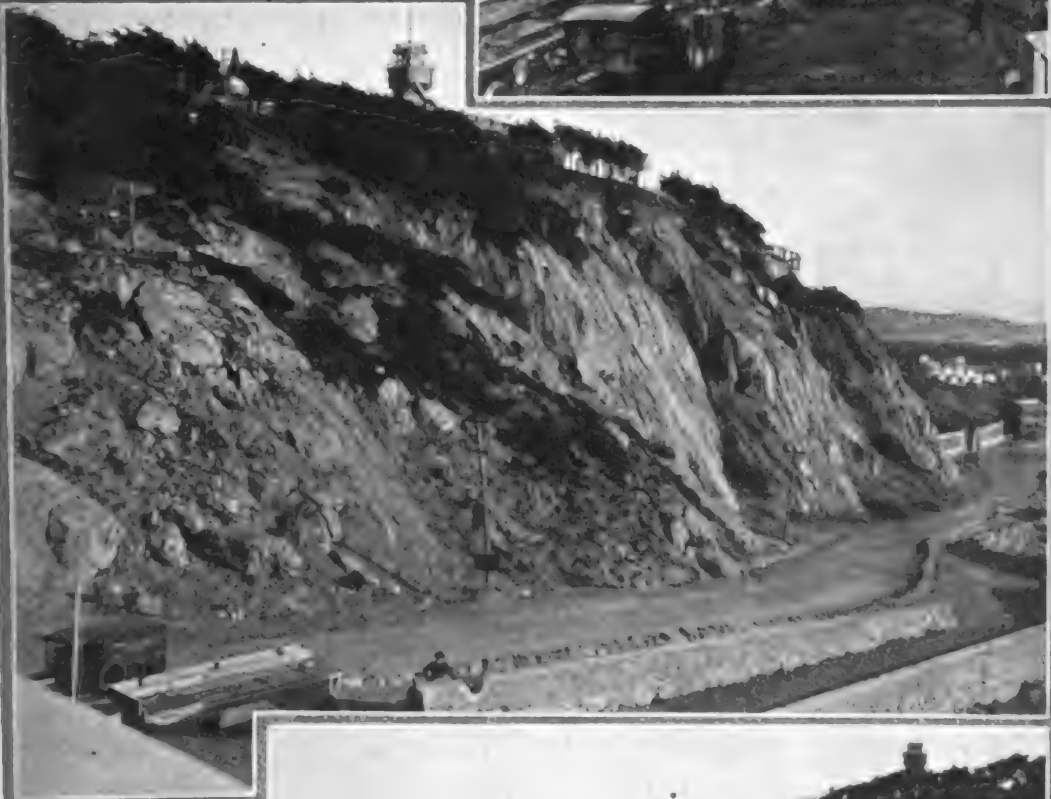
VOL. XV.

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Cliff House Drive, San Francisco, Calif.

After several years of delay, the roadway skirting the Cliff House and Suto Highways in San Francisco has been changed into a beautiful paved boulevard, 2400 feet long, 60 feet wide, and with a grade varying from two to nine per cent. At the right is a view of the construction work in progress.



In the center of the page is a photograph of the Cliff House Drive before the new construction work began.

At the right is a view of the finished drive. The improvements consist of a rubble wall, rubble parapet, artificial stone sidewalks, and asphalt concrete pavement.





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FRANK E. KENNEDY.....Associate Editor
LOUIS A. GRAHAM, M.E.....Consulting Editor

Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Yes, It's Quite a Job

About \$1,250,000,000 all told for federal, state, county, district, township and city highway construction and maintenance was expended last year in the United States. The federal and state appropriations for state highways alone totaled \$800,000,000, the city and town appropriations for streets and roads totaled \$285,000,000 and the remainder represents the funds expended by the counties, parishes, road districts and townships.

Compared with the 1923 road construction in the United States, the construction of the great Roman highways, the erection of the pyramids, the building of the Chinese wall and the excavation of the Panama Canal pale into insignificance. The 1923 gain over 1922 was approximately \$125,000,000.

Which Is It?

The Pennsylvania State Highway department in deciding the question, which arose in the registration by an undertaker of a number of motor vehicles, that a hearse is a passenger car rather than a commercial vehicle. Against the opinion of the department it was contended that a hearse should be classified as a truck.

Smoothing the Way

One day an old umbrella mender brought his skeleton frames and tinkering tools into the alley of my office. As he sat on a box in the sun, mending the broken and torn umbrella, I noticed that he seemed to take unusual pains, testing the cloth, carefully measuring and strongly sewing the covers.

"You seem extra careful," I remarked.

"Yes," he said, working without looking up, "I try to do good work."

"Your customers would not know the difference until you were gone," I persisted.

"No, I suppose not."

"Do you ever expect to come back?"

"No."

"Then why are you so particular?"

"So that it will be easier for the other fellow — the next one who comes along," he answered simply.—Selected.
(A moral all us may profit by.)

The Road Hog

The road hog went his merry way
And he was going west.
To crowd 'em over and crowd 'em off
He did his level best.

Another road hog hove in sight
And he was coming east,
To crowd 'em over and crowd 'em off
He cared not in the least.

They met—two piles of junk lay by;
Ha ha! we laughed—and then,
Out crawled the charmed degenerates
To hog the road again. —A. S. G.

American Society of Civil Engineers Meets This Month

The Texas Section, American Society of Civil Engineers will hold its annual Spring Meeting on March 20, 21 and 22, 1924, at Brownsville, Texas. Special features of the program will be the presentation and discussion of papers on engineering subjects including irrigation, railway terminals and stream measurements. Trips of inspection will be made over some of the noteworthy irrigation projects in the Rio Grande Valley with side trips to Matamoras.

The Crack That Stops Cracking

By PAUL D. SARGENT,
Chief Engineer Maine State Highway Commission

How irregular, longitudinal cracks in concrete pavement are eliminated by the introduction of a center construction joint dividing the pavement into two sections.

BUILDING concrete roads with a crack in them to prevent cracking is the latest engineering wrinkle in highway construction. One of the embarrassing defects encountered in concrete pavement slabs having a width greater than 16 feet is the formation of unsightly longitudinal cracks brought about by the combined stresses produced by nature and traffic. To eliminate such cracks the center of the pavement must be thickened to a dimension not justified by economy. However, this may easily be circumvented by introducing a longitudinal center construction joint dividing the normal two-track country pavement having a width of 18 feet into two nine foot sections.

Slabs nine feet in width have never caused any difficulty so far as longitudinal cracking is concerned. By proper interlocking and tying together of these two nine foot strips the center portion of the pavement may be made practically as strong as an unbroken slab and certainly far more efficient than a pavement divided by an irregular longitudinal crack.

In connection with this same policy



Illustrating the manner in which the half-inch steel reinforcing bars are placed in the concrete road. Ten pounds of steel are used to each square yard of surface.

the old idea of a heavy rock foundation for such ways has been abandoned and the improved method is to place the concrete directly on the sub-soil with, possibly, a cushion of gravel according to the nature of the soil.

As an example of this new method, take the 23 mile stretch of concrete road between Portland and Auburn, Maine, known as the "Heart of Maine" highway. The construction of this was begun in 1920 and additional sections have been completed each year since until its completion in the fall of 1923. Sections of this road laid in 1920 and 1921 were on a heavy rock base with solid concrete slabs 40x18 feet. A survey in March, 1922, to determine what percentage of the concrete slabs had cracked, showed that only eight per cent of the total had been cracked by frost. The remaining 92 per cent were untouched and practically perfect. This was considered an excellent showing but in 1922 it was decided to use the divided slab type of construction and to decrease the thickness of the pavement one inch. These slabs were laid directly upon subsoil in



One half of the pavement completed. The two 9-foot slabs are connected by the steel dowels which may be seen projecting from the finished slab.

sections 40x9 feet and reinforced both longitudinally and transversely with one-half inch steel bars so that approximately 10 pounds of steel was used to each square yard of surface.

The cost of this reinforcement is offset by the amount saved in decreasing the thickness of the pavement by an inch and therefore does not add to the ultimate cost of the road.

The two nine foot wide slabs are connected by steel dowels 18 inches long, nine inches of which is firmly imbedded in the first half laid; and the other nine inches, after being covered with paper or painted with an asphaltic paint, is allowed to project into the adjoining slab. This covering of paper or paint prevents the steel becoming firmly fixed in the center joint, allowing a considerable amount of play, so that, if by any chance, there is a heaving in spring from frost the dowel will draw the slabs back into place again without harmful results.

This same type of construction was also used on a section of highway built near the University of Maine in Orono, where it was under the constant supervision of the professors of engineering of that institution. The winter of 1922-23 was one of the most severe experienced in Maine in a considerable time, yet both sections of this road construction came out in the spring of 1923 free of cracks caused by frost or traffic stress.



The other section of concrete road built along the new reinforcement and center crack plan to prevent longitudinal cracking. This photograph was made at the time the frost was leaving the ground, in the spring of 1923.



Paul D. Sargent, Chief Engineer of the Maine Highway Commission, speaking at the opening of the "Heart of Maine" Highway. Mr. Sargent tells in the accompanying article how the "Heart of Maine" Highway was constructed.

The joint or crack between these slabs following a regular course constitutes a traffic center line which increases the safety of the highway users from 25 to 50 per cent. Where a traffic center line is used drivers no longer pass each other with a more or less uncertain clearance between their cars, but approach with confidence, using the center lines as a positive visible gauge from the driver's side and knowing that the clearance thus afforded will insure absolute safety in passing without danger of running off the unseen outside edge of the pavement.

On curves the traffic center line is of even greater advantage than on the tangents.

A WARNING

People who haven't time to stop at a grade-crossing manage to find time to attend the funeral.

The New Road and the New Library

By ANNA A. MacDONALD,

Consulting Librarian, Library Extension Division, State Library, Harrisburg, Pa.

"The new library is following the new road, contributing a part to the life being lived by its side....."

IT is a great thing to have lived long enough to be able to measure the value and development of an idea; to have the idea which was scouted and doubted at first, so accepted and used in every day life that only the older, remembering ones ever think of the time when life was different.

Thus, there is the vivid childhood memory of driving over the mountain roads of Virginia in a "spring wagon" made by the father of the family out of stout hickory wood, strong enough to stand the wear and tear of rocky trails.

And as a part of this childhood impression there is the remembrance of the books often taken along on these drives to be returned to the owners, or loaned to a kindred spirit. Especially there stands out the time when "Dombey and Son" was borrowed on its way

around this circle of reading friends, and of an Aunt, who, in the midst of a very hard, busy life taking care of the farm household and three small children, somehow each day found time to read a new chapter so that each night there was more to add to the bed-time story of "Paul" and "Florence" and "Walter."

Or there was a visit to John and Susan in the kitchen, where there would live for a time "Brer Rabbit," "Brer

Fox" and "Brer Coon," with their many sayings and doings, all in the same dialect.

With the picture of this childhood experience in mind, a trip was made recently over a new State Highway in much the same sort of district, though in another state.

What a contrast between the "now"



All the children are on hand to greet the book wagon which is part of the service of the Evanston, Ill., Public Library.



Where the Traveling Library is Doubly Welcome. An old lumber camp on Plum Creek, Sawyer, Wisconsin.



Good roads in South Carolina have made possible the traveling library, with headquarters at Greenville, S. C.

and the "then." The old dirt road with its up-hill and down, its rocks and ruts, mud-holes and "thank-you-mam's" was replaced by a truly regal highway—a wide ribbon of concrete connecting the little village with the larger town some fifteen miles away—a long half day's journey in the past accomplished in half an hour.

And along this highway there passed no longer the horse-drawn wagon, buggy and carriage, but motor-driven trucks, automobiles and motorcycles. The man sped by on his way to work, the laundry car, the bakers and the butchers all served these wayside homes. A bus stopped every now and then to pick up children for the Township Schools a few miles further along; the rural mail delivery car followed soon after.

Truly, good roads and motor cars are the fairy wands that enable man to have all the joys of living in the open country, and at the same time to have all of the comforts and pleasures the city gives. Those who first dreamed of good roads must look upon such highways with much satisfaction.

However, there was one truck not seen upon that highway. There was no book truck, no County Library sign, no books being delivered as was the bread, meat and laundry!

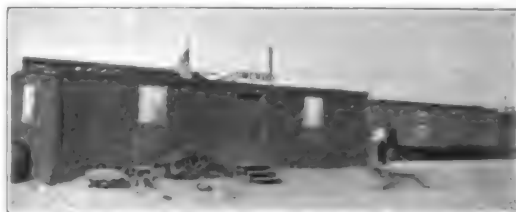
All the physical comforts were being provided for, but little for the spirit. In this, there was no contrast between the "now" and the "then." There was no improvement over the old method when that family of children with plenty of time, the ability and the desire to read depended upon others to tell

them the stories of "Uncle Remus," of "Paul and Florence Dombey," and of the wonder stories of the old Greek and Roman mythology. And there are now as there were then countless other children not so fortunate as to have parents capable of satisfying youthful hunger for books.

With the change in our conception of what a good road should be, there is also coming a marked change in our conception of what an education should mean. Just as the day of the dirt road and the horse-drawn wagon have passed into history, so has the idea of education being confined to the childhood-days and textbooks passed.

The useful man does not stop studying when he stops school; he goes on indefinitely, building on the foundation the school has given him, educating himself in his special line and for his special needs.

To do this, books are necessary—more books than any but the very wealthy can afford to buy, near enough so they may



One of the Inyo County, California, free libraries, located in a made-over freight car.

be had promptly, and cheap enough so they may be afforded.

To supply this need, just as the butcher, the baker and the laundryman have changed their old methods of business to give the service the new highway has created, so has the Public Library adapted its methods to the new conditions.

Instead of the town library for the use of the townspeople alone, we now have the County Library for the use of all the residents of the county. It is supported by the county so that the cost is not prohibitive, and so placed throughout the county that all may have ready access to the books. All this is under the care and -direction of a trained, experienced -librarian who knows how to secure a good selection,

where to buy to get them for the least cost, how to take care of them so they last as long as possible, how to catalog them so the subject matter in them may be easily found. And best of all, she knows how to distribute them, by placing small libraries in towns and villages, in stores, schools, Sunday Schools, Granges and community centers, with a book truck for those living away off by themselves, so that **EVERYBODY** in the county may have free, easy, prompt access to them.

There will be books to read by the fireside during the long winter evenings and for the lazy minutes in the hammock in summer; books for the children to give them pleasure as well as to teach them things and help with their school problems; books on every subject man has thought of and written about; all this within reach of every one who cares to use them, and at a cost any county can afford.

Just as an example of this, there is that man who has started to build the small home on the hillside there at the turn of the road. He is evidently doing much of the work himself. Let us see what use he might have made of such a County Library, if one had been there.

First, he could have gotten books on the country home; how to select the ground, what exposure to look for, the best kind of soil and drainage to have. Then he could have posted himself upon the legal side of the purchase and financial arrangements—the deed, insurance, mortgage, if one were needed, costs, etc.

Then there are plans of houses with



The bookwagon of the Elkhart, Indiana, Public Library is really a small library complete in itself.

the materials used in building them, giving comparative values of wood, brick and stone as building materials and how to use them in constructing the house. There are books on plumbing, heating, ventilation—all the information for which an architect gets a good round sum if he furnishes it.

When the house is built, there is the finishing, the decoration, the furnishing—all of which may be as dainty and pretty in a small inexpensive house as in a large architect-planned one, and the knowledge of how to do it gotten by oneself without cost if the books are at hand and one knows how to use them.

There are books for the mistress of that home on food,—the care of it, its values, combination in menus, preserving and drying; on the children—their care, management, food, dressing, nursing; on household economy and her budget.

And the County Library will furnish all this information to him and his family, supply them all the year with a most delightful recreation, increase by a third the value of the time the children spend in school, and all for the cost probably of one of the books on one of the subjects mentioned above—just a few dollars a year spent through the library tax.

This is no idle dream any more than the new road is a dream. The new library is following the new road, contributing a part of the life being lived by its side that is as essential as any of the educational and recreational elements are, and may be secured just as rapidly as the people who live there demand it.



Old and young appreciate the value of good roads, which enable the Washington County, Maryland, book truck to reach every farmstead.

Corrugated Culverts Make Fine Record in Arizona

One of Yavapai County's pioneer supervisors inspects drainage structures he installed in 1907 on the Prescott-Jerome highway, part of Arizona's proposed "Wonder Road."

PLANS for Arizona's Wonder Road—"A Thousand Miles of a Thousand Wonders," as it has been tentatively christened—are taking shape in the form of a highway project that will ultimately unlock to the motor-wanderer the mysteries and splendors of old-young Arizona.

Although Arizona did not become a state until 1912, it is needless to say that some of the finest road construction in the southwest was going on back in the territorial days.

The photograph at the right shows one of Arizona's pioneer road builders, former Supervisor Barney Smith of Yavapai County. It was under the direction of Supervisor Smith, who held office from 1905 to 1912, that many miles of the picturesque Prescott-Jerome highway were first graded and drained, and saw the first semblance of maintenance.

A veteran culvert installation is shown in the photograph with Supervisor Smith. This Armco ingot iron culvert dates back to the territorial days, having been installed by Mr. Smith in 1908, near Prescott.

It is only one of scores of Armco cul-



Former Supervisor Barney Smith, of Yavapai County, Arizona, installed the Armco culvert shown in the above photograph, in 1908—four years before Arizona became a state.

verts which Supervisor Smith installed in 1907 and 1908 and which he personally inspected last year.

Regarding his inspection tour the pioneer supervisor of Yavapai County states: "As far as can be seen, these culverts are as good now after 16 years in the ground as the day they went in."



One of the many Armco ingot iron culverts installed on the Prescott-Jerome road in 1919. This road is one of the heaviest pieces of highway construction in the West and was built by the State with Federal aid.



A fine stretch of well maintained gravel road in Marathon County, Wisconsin. Adequate drainage is an important factor in the proper maintenance of Wisconsin highways.

Maintenance Costs on Wisconsin's State and County Highways

By J. T. DONAGHEY,

Maintenance Engineer Wisconsin Highway Commission.

BEFORE the plan of county road maintenance in Wisconsin was finally decided upon, the question was debated whether or not the county or the state was the logical unit through which to work in the matter. It was said that under the state plan the highway commission would be in closer touch with the work, and that it might, therefore, be handled more promptly. But it was also figured that to finance it, an appropriation sufficient for the purchase of about \$2,000,000 worth of maintenance equipment would be necessary. Such an amount is difficult to secure from a legislature in a hurry. It would also mean that state and county crews would often be working in close proximity, and since state forces are permitted to work only eight hours a day, while country forces may work ten, this factor was feared as a trouble brewer.

On the other hand, if the roads were maintained by the counties such equipment as they already possessed could be used, thus avoiding the purchase of duplicate equipment, work done by local people would be apt to progress better, and with less destructive criticism from the community than would similar work done by the state.

Furthermore, the fact that counties were taking care of their own maintenance work would inspire them to desire a larger and larger mileage of good roads for their territory. It was recognized that in this system there might in some cases be friction due to lack of co-operation with the state department, and perhaps the work might cost more than it should, due to lack of proper supervision, but after weighing everything, these possibilities seemed more easily obviated than some of the others in the other plan, consequently the state decided in favor of the county maintenance of roads.

HOW THE COUNTY FUNCTIONS

Each county is governed by a county board consisting of a representative from each township and village, as well as one from each ward in every city. This board elects a committee of three to represent it in all matters pertaining to road work, and it also elects a county highway commissioner who has direct charge of all road construction and maintenance in that county. To insure close supervision, he is expected to visit each patrolman at least twice a week. The function of the county road committee is really that of a liaison officer

between the county highway commissioner and the county board on the one side, and the state highway department and the county board on the other.

During the first month of the patrol maintenance in 1916 the driving conditions in the state were improved far more than even its best friends thought possible. Several county boards met during the month following its inauguration and provided for adopting patrol maintenance on important secondary roads. The growth of this idea is shown in the following table, which shows the number of miles of county trunk highways taken over for maintenance each year by the various county boards, the number of patrolmen employed, their salary, the cost of marking and signing, and the total amount of money expended.

Year.....	1918	1919	1920	1921	1922
No of Miles Maintained.....	2,021	5,590	7,743	8,980	9,685
No. of Patrolmen.....	232	705	970	1,123	1,236
Average Monthly Salary of Patrolmen.....	\$125	\$140	\$160	\$150	\$145
Cost of Maintenance.....	\$475,000	\$1,226,267	\$1,435,527	\$1,867,615	\$2,279,804
Cost of Marking and Signing.....		3,600	9,300	8,100	11,000
Total Expenditures.....	\$475,000	\$1,229,867	\$1,444,827	\$1,875,715	\$2,290,804

The above total expenditures average \$214.00 per mile per year.

This table shows that the system of county maintenance is a good one in that it spurs the counties on to greater



This Armco culvert, installed in Green County, near Juda, Wisconsin, eliminated an almost impassable mudhole.

effort in the attainment of a greater good roads mileage each year. In addition to the 7,500 miles of state trunk system, Wisconsin now has a 9,880 mile county trunk system, making a total of 17,380 miles of well maintained roads.

WISCONSIN'S MAINTENANCE COSTS FOR STATE TRUNK HIGHWAYS

In 1917 the Wisconsin state legislature provided for a 5,000 mile state trunk highway system. The legislature of 1919 increased this mileage to 7,500. The table herewith appended shows the actual miles maintained by patrol methods each year, the number of patrol sections, the salary paid to patrolmen, the patrol maintenance cost of each type per mile, and the amount expended per mile out of the maintenance fund for "betterments." "Betterments" consists of widening the road and providing drainage with heavy blade grader work, light resurfacing, new culverts, and the cost of marking and signing the highways.

Year.....	1918	1919	1920	1921	1922*
Actual Miles Maintained.....	4,998.9	4,998.9	7,234.0	7,260.4	7,458.59
No. Patrol Sections.....	561	561	791	911	940
Monthly Salary Team Patrol.....	\$130.00	\$145.00	\$165.00	\$155.00	\$150.00
Monthly Salary Motor Patrol.....	\$90.00	\$110.00	\$125.00	\$115.00	\$100.00

PATROL MAINTENANCE COST PER MILE

Earth.....	\$135.21	\$154.01	\$187.24	\$196.21	\$186.40
Gravel.....	\$120.80	\$133.63	\$184.68	\$193.85	\$183.25
Stone and Gravel Surface Treated	\$574.21	\$626.33	\$706.11	\$682.23	\$671.84
Concrete**.....	\$162.21	\$210.42	\$220.18	\$322.21	\$311.85
Cost of Patrol Maintenance.....	\$573,042.16	\$ 767,302.12	\$1,220,535.00	\$1,326,927.24	\$ 1,335,900
Cost of Betterments.....	\$396,449.65	\$ 488,529.68	\$ 756,474.38	\$1,028,976.04	\$ 952,850.00
Cost of Marking and Signing.....	\$ 7,888.22	\$ 17,776.16	\$ 28,820.61	\$ 20,462.14	\$ 41,250.00
Total Expenditures.....	\$977,430.93	\$1,273,607.86	\$2,005,829.89	\$2,381,413.85	\$2,350,000.00

The above total expenditures average \$278.00 per mile per year.

Advertising Lessens Auto Death Toll

By HARRY

E. CAYLOR.

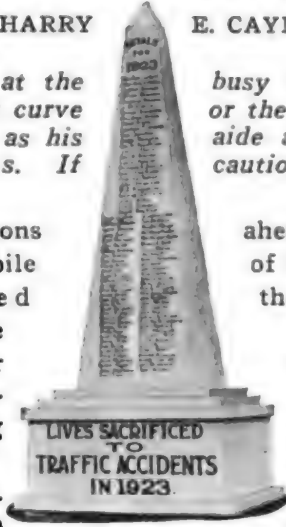
When death takes his stand at the crossing, the dangerous highway curve game begins with recklessness as his The stakes are human lives. If

busy traffic corner, the railroad or the school playground, a grim aide and caution as his enemy. caution is displayed, death loses.

A TOTAL of 11,666 persons were killed in automobile accidents in the United States in 1922 and responsible estimates place the death toll for 1923 as high, if not higher. Public "safety" campaigns are being redoubled.

Into this fight against carelessness that is responsible for 90 per cent of the fatalities, has been summoned Advertising, the "doctor" of industry and commerce. Advertising's prescription is a liberal dose of caution, continually administered.

Nearly every state, city and community is helping in this campaign to stay the hand of death. The press daily gives its warning with accounts of accidents that might have been avoided. Along the streets and highways, signs are erected to tell the motorist what is



A Monument to the Victims of Peace.

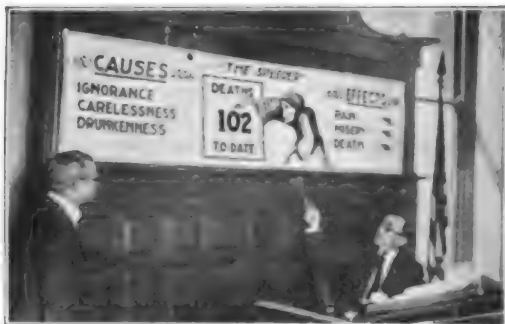
ahead, and these signs form one of the most unique chapters in the history of advertising.

All carry the message "Be careful." Their very grimness stamp into the mind the horror of carelessness, the terror of skidding wheels on slippery pavements, collisions on sharp curves and the tragedy of speed.

Most forceful, perhaps, among the warnings erected by cities, as perpetual reminders to the public, is St. Louis' monument "in memory of child life sacrificed on the altar of haste and recklessness." The monument comprises a square base supporting a broken column which symbolizes the lives cut off before maturity. It was dedicated recently to 32 children who had been killed by automobiles in a year.



Three distinctive methods of advertising used to lessen the auto death toll. At the left is a striking sign which warns the motorists of a dangerous curve near a school crossing. In the center is the Speedometer of Death, erected in Lafayette Square, Buffalo. At the right is the Broken Column Memorial, symbolizing the lives of St. Louis children cut off before maturity.



This striking warning faces the auto speeder who comes before Judge Meredith Yeatman, in the Cincinnati Municipal Court.

The Sixth regiment band played a dirge during the unveiling. Children placed flowers above the base and a dirigible from Scott Field, nearby, dropped wreaths. St. Louis officials declare that the warning has resulted in a decline in the number of child victims.

A similar monument was erected during the last year in Detroit. It, too, was dedicated to victims of traffic accidents. On a huge shaft is inscribed the names of persons killed in the city by automobiles and street cars in 1923.

"Don't Kill a Child" is the plea of a sign at a dangerous curve near a school crossing at West Palm Beach, Fla. Above the illustrated legend is a plea to "Obey the Law." Another unique sign on the Dixie Highway near Miami commands the motorist to "Save a Life." It is shown on this page.

Buffalo has erected a "Speedometer of Death" in Lafayette Square. The speedometer daily records the number of fatal accidents in the streets, similar to the way the automobile speedometer records the miles covered.

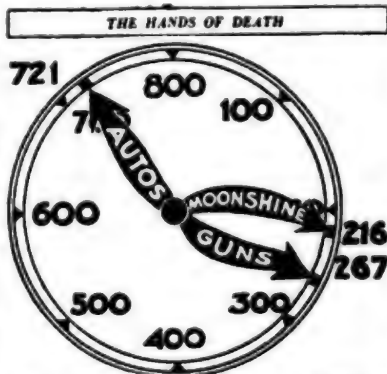
An unusual and effective concrete road marker has been placed on Hughes Hill, Berks county, Pennsylvania, on the road between Reading and Hamburg to warn motorist of a dangerous curve ahead. It is an exact duplicate of the usual type of tombstone and on its face

is chiseled a skull and cross-bones. Underneath is the warning "14 Miles to the Nearest Hospital."

Edward Eisenbrown, of Reading, Penna., placed the marker. He declared that if it saves even one life he will be repaid for his trouble. He plans to erect other similar stones on the same road.

Even the courts which lately have been showing a tendency to jail speeders instead of merely fining them are utilizing signs to impress the need of carefulness. Above the bench of Judge Meredith Yeatman, of the Cincinnati Municipal Court, is a long panel showing the total traffic deaths for the year. Over the numerals are two words "The Speeder"; on the sides are given the speeder's "cause" and "effect." Under the word "Cause" are listed "Ignorance, Carelessness, Drunkenness," and under "Effect" are "Pain, Misery, Death."

The Chicago Tribune, one of the Metropolitan newspapers strenuously fighting the "speeder evil," prints daily a "clock" with three hands, described as "the Hands of Death." The hands designate daily the number of deaths from accidents, guns and "moonshine" liquor in Cook County, Ill. The hand indicating automobile deaths is far ahead of the others, the total for 1923 being 721.



The death clock of Cook County, Ill., as it appeared, Dec. 31, 1923.



A grade crossing sign on the Dixie Highway in Florida.

"Hi-way Guard" First Practical Device to Prevent Embankment Accidents

Embankment accidents along the country's highways have caused hundreds of deaths in the last few years. Motorists who have suddenly come upon a sharp curve with a cliff below, have felt their wheels skidding towards the steep roadside or have plunged over, know the terror that lurks behind these inclines. Two years ago the Page Steel & Wire Co., the oldest woven wire fence manufacturers in the U. S., started experiments that resulted in a "Hi-way Guard" to prevent such accidents. It has aroused much favorable comment and endorsement from highway officials and engineers.

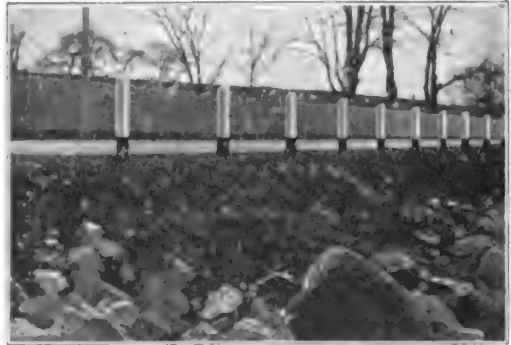
A HIGHWAY safety appliance, simulating the aerial life-net in preventing the "40 per cent of fatal highway accidents that result from automobiles plunging over bridges, embankments and road curves," has been perfected as part of the fight to cut down the nation's high traffic fatalities.

The appliance, termed a "Hi-way Guard," has aroused the interest of safety and traffic experts and the endorsement of highway engineers. Highway officials of three states are already writing it into their specifications, making it a standard in their states.

The "Hi-way Guard" was created and is sponsored by the Page Steel & Wire Co., for many years manufacturers of wire link protection fence, for factories, institutions and estates. This wire link construction is the strongest and most elastic fabric made for protection purposes. When installed at the roadside, it stops speeding machines by the stretch of the fabric without destructive impact. Highway engineers declare it is the first practical appliance strong enough to stop an automobile and at the same time stop it "easy" enough that the occupants are not abruptly hurled out over the side or front of the car.

The "Hi-way Guard" was first successfully tested by engineers under the "pendulum" method for testing bumpers approved by the Underwriters Laboratories. This Underwriters test consists of striking the fabric of the guard with a 650 pound weight constructed of 12-inch pipe filled with concrete, suspended from a height of 68 feet.

The weight was drawn five to thirty



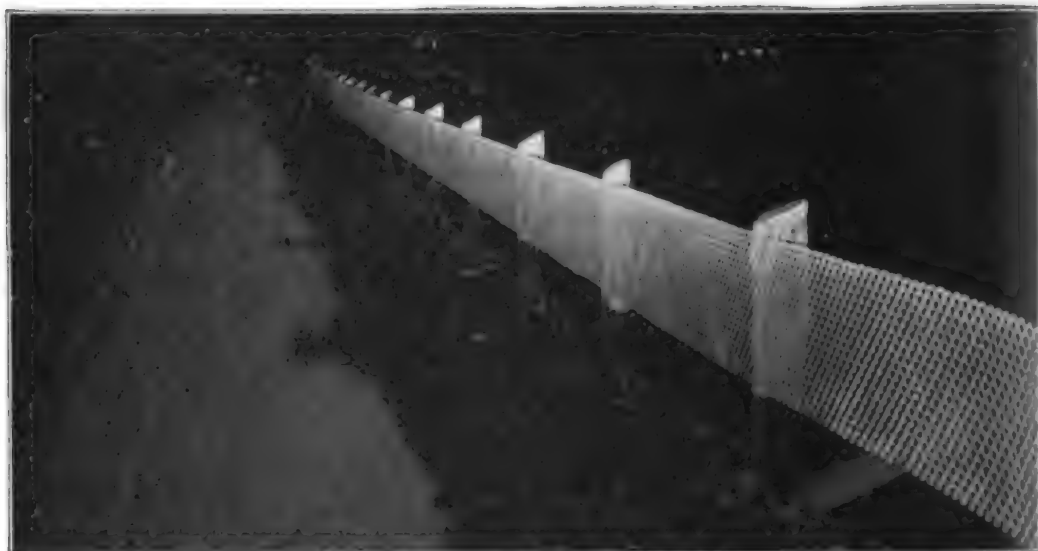
A section of the "Hi-way Guard" installed at the top of a steep, rocky embankment on one of Connecticut's important highways.

feet away from the "guard" and released, striking the face of the fabric at right angles. The force of the blows dealt the "guard" were equal to the impact force of a 3,000 pound car traveling at 5, 10, 15, and 20 miles per hour.

In these tests, like the subsequent ones in which automobiles were used, the "Hi-way Guard" withstood the blows. Neither the weight nor the cars were able to break through. The wire link mesh, elastic but firm, stretched and elongated under the impact of repeated blows, but could not be broken.

Embankment accidents have taken a toll of many hundreds of lives in the United States in the last few years. Heretofore, other types of guard rails designed to keep machines from going over cliffs have been so impractical that they served merely as warnings.

Writing in the July, 1923, issue of *The Highway Magazine*, Frank S. Peck,



How the "Hi-way Guard" looks at night—a clearly visible, white, woven wire band, that actually prevents cars from going over unseen embankments.

highway engineer of Lawrence County, South Dakota, said:

"Wooden guard rails employed on many state and federal aid roads are constructed in such a flimsy manner that all they amount to is simply a guide and have little or no value as protection.

"On any of the well-traveled highways one can see a great number of places where cars and trucks have knocked out two or three panels of the generally used light guard rails.



Another installation of the "Hi-way Guard" in Connecticut, showing the comparison between the new steel and the old wooden guard rail.

"The Hi-way Guard," said W. T. Kyle, Assistant General Manager of the Page Steel & Wire Co., in telling of the motive and work of its perfection, "is the result of two years of laboratory and highway engineering experiments, provided for in a fund set aside for the work by the Page Steel & Wire Co. because we believe that the problem of high automobile fatalities on roads is one that industries must solve for economic reasons.

"The National Safety Council and other competent authorities estimate that the economic cost of traffic accidents for each 100,000 population totals \$1,500,000 per year in the United States. I believe it is the duty of industrial concerns which possess facilities to unite in efforts to find practical preventatives for this appalling death rate and economic loss. It was this belief that caused us to deviate from the usual activities of a concern such as ours and start the work that resulted in the safety appliance. And, although the guard is practical and inexpensive enough to be highly marketable, our immediate concern is going to be to get them placed at several locations proven highly dangerous by bad accidents, and with this in view we are offering the National Safety Council several of them, to be placed by us where they designate."

Demonstrating the Improvement of Earth Roads

By CLYDE H. HOOLEY,

Instructor in Highway Construction and Maintenance, Ohio State University.

The writer describes a series of earth road demonstrations conducted by the Agricultural Extension Service Department of the Ohio State University, and tells how instruction in proper methods of ditching, grading and shaping of earth roads has awakened keen interest in the counties of southeastern Ohio.

WITH an ever increasing number of motor vehicles, Ohio is facing an extraordinary task in highway construction and maintenance. Present financial resources are entirely inadequate for these purposes, especially in view of the practices employed by many who have charge of this work.

In the past three years it has been my privilege to observe highway conditions in at least 60 per cent of the counties of the state and it is a regrettable fact that in too many counties, DRAINAGE, the most important feature of a road, is neglected. This applies to county roads and more especially to the township roads. Generally speaking, the improved portion of the state road system is well drained.

In the discussion of road improvement before Farmers' institutes, County Commissioners and Township Trustees' conferences, it was also observed that too many road officials, especially township trustees and road superintendents fail to have a conception of a properly



Photo No. 2. This shows the road chosen for demonstration, widened to 18 feet and side ditches in the process of construction.

graded and drained road-bed, which results in an enormous waste of road funds.

Application of any type of road material to an improperly drained road-bed is like an application of manure or com-



Photo No. 1. An almost flat road in Southern Ohio, selected by the Agricultural Extension Service Department of Ohio State University for the purpose of demonstrating earth road construction.

mercial fertilizer to an improperly drained soil.

In order to assist in correcting conditions just mentioned, we are conducting a campaign of education through the agricultural engineering department of the Ohio State University Extension Service Department, by way of illustration and demonstration. Lantern slides showing grading and drainage in its various steps of construction were used when meeting with county and township road organizations. These created an enthusiastic interest which led to an actual road grading demonstration conducted under the auspices of the Extension Service Department.

Our first demonstration was conducted in Morrow County, in May of last year—150 people being present, including 37 out of the 48 county trustees, several county commissioners and surveyors. Quite a number of people attended from adjoining counties. Our object in this meeting was to properly grade and drain an old narrow dirt road about a mile in length.

The farmers adjoining this road agreed to keep this improved section of road well dragged. This has been done and the road is in fine condition.

Our work this year will be confined mostly to eastern and southeastern Ohio,



Photo No. 3. The old wooden culvert, one end of which was completely clogged, taken from the road shown in Photo No. 1 during the demonstration.



Photo No. 4. This shows an extremely dangerous method of grading — roof shaped, dangerous in wet weather, and inconvenient for driving even in dry weather.

in what might be classed as the dirt-road section of the state. At least 80 per cent of the roads in this section are of the dirt variety, many miles of which, at comparative small cost, could be improved 100 per cent. It is now planned to give several grading demonstrations the coming season to prove the truth of this statement.

The accompanying illustrations are scenes connected with a demonstration given in southern Ohio last September. Photograph No. 1 shows an almost flat road—the subject of our work. No. 3 shows an old wooden culvert, one end completely clogged, found in the road shown in Photo No. 1. No. 2 shows the same road widened to 18 feet and side ditches in process of construction, a ditch that will afford good drainage and not given to filling in by frost and sunshine. No. 4 shows an extremely dangerous method of grading. Roof-shaped, dangerous in wet weather and inconvenient upon which to drive a machine in dry weather. This method prevails in some sections.

A section of road properly widened and graded where such bad grading methods prevail will serve as a great object lesson by way of comparison. A campaign of education will do more than legislation toward the solution of our acute road problems, and such campaigns liberally seasoned with enthusiasm and common sense will not bring forth resentment from the hearts and minds of our elected road officials, but on the contrary, it will insure their hearty co-operation.

Irrigation and Drainage

Irrigation Equipment Used in Oil Industry

How the oil industry employs irrigation flumes, gates and culverts in salvaging oil and preventing water pollution in California.

THE accompanying photographs shown herewith depict one of many such installations of Calco Slide Headgates, Armco Culverts and Armco Flume used by the Oakridge Oil Company, a company associated with the Ventura Refining Company, of California.

The Oakridge Company has a number of oil wells on the hillside across the



The skimming vats of the Oakridge Oil Company, located near Santa Paula, California. The outlets are controlled by twelve Armco corrugated pipes fitted with Calco slide headgates.



Many Armco culverts are used in the Oakridge District of Ventura County—both for drainage and for oil pipe lines.

river from Santa Paula. Storm waters carry away considerable oil which would normally enter the river about a mile below. As the water is taken from the river for irrigating purposes the presence of oil would be detrimental to crops and cause lawsuits between the ranchers and the Oil Company.

Therefore, a skimming vat was installed through which all runoff water must pass. The oil is collected and pumped back up the hill where it goes to the refinery while the water passes on down into the river.

The value of oil recovered in a short period of time after this installation was made, paid for it, aside from the other advantages gained.

There were twelve Calco Slide Head-



A view of two of the Calco slide headgates installed in connection with the Oakridge Oil Company's skimming vats.

gates, Model 101, employed here, all with sections of Armco pipe attached. Also a section of Armco flume is attached to the lower side of the concrete structure into which the overflow empties and to a catch basin at one corner.

The Oakridge Oil Company has also used a considerable quantity of Armco flume in their hillside work.

A large number of Armco culverts have been installed in road drainage work throughout this district as well as many installations used as oil pipe lines.

Yakima Potato Growers Plan to Reduce Losses

In the Yakima Valley, Wash., potato growers are working on plans to prevent a repetition of losses suffered in the last few years from lack of a readily accessible market. Probably the Yakima Valley produces larger yields of potatoes of the highest grade than any other area in the country. The Yakima reclamation projects in 1922 produced an average of 260 bushels an acre on the 8,442 acres harvested. Yet the growers lost money, and a large part of the crop had to be dumped back on the fields.

To reduce such losses in the future, new plans for marketing the choicest grade of potatoes are under consideration. It is proposed to grade and sort the potatoes, wrap each one in paper, and pack them in small boxes for shipment by the Panama Canal to eastern markets. Potatoes thus packed, it is figured, could be laid down in New York at a cost for transportation of \$1.25 a hundred pounds, and would command premium prices.



One of the many Armco corrugated culverts employed in the drainage operations of the Holland Land Company, California, described in the article on the following page.

Adequate Drainage Makes Holland Land Project Highly Productive

IN an article published in the March 1922 issue of *The Highway Magazine*, written by J. R. Smith, Engineer for the Holland Land Company, California, regarding the use of Armco culverts in the reclamation of the 25,000 acre tract of rich tule land owned by the Holland Land Company, Engineer Smith made the following statement:

"The successful operation of a tract of reclaimed land, regardless of its natural resources, depends upon adequate drainage. Even the best land when allowed to become saturated with water, which often contains injurious substances, will quickly revert to its natural state or even support no vegetation but alkali weeds. And, conversely, water properly applied to land is the basis of increased production."

The last annual report of the Holland Land Company contains some decidedly interesting facts regarding the development of this project along the lines outlined in Engineer Smith's article published in *The Highway Magazine* two years ago.

RECLAMATION of the Holland tract was effected by the organization of a reclamation district and the expenditure of approximately \$80 per acre. No bonds were issued. At present there are outstanding warrants to the amount of approximately \$7 per acre which represents the entire remaining indebtedness of the district on account of reclamation.

The outstanding fact about the Holland project at this time is that it has ceased to be a "project" and has become a settled and productive area, a prosperous, contented and forward looking community.

The lands of the Holland tract, with exception of limited areas along the river and slough banks, are as level as a billiard table. For miles and miles the roads traverse a level plain that is really level; drainage ditches border the roadways; irrigation ditches are seen in many fields.

The irrigation system practiced on these level lands is the simplest and most inexpensive. Water is not applied to the surface as in the case of up-valley lands; parallel ditches are made through the fields, ranging from 50 to 150 feet, and these are kept filled with water to the proper level. The sub-strata is porous and the level of the ditches is the



An Armco ingot iron flume distributing the water for the irrigation of sugar beets. Twenty-six tons of sugar beets to the acre have been grown on the Holland Land Company project.

level of the water throughout the tract irrigated. Water for this purpose is supplied from the river by siphon over or through the levees on the river and slough banks.

The past three years have witnessed a remarkable change in the character and value of crops grown on the Holland district lands. This is best illustrated by the passing of barley as an important crop. Three years ago the area devoted to barley was 15,000 acres, this year it was about 1,500 acres.

It is most interesting to note the dis-

tribution of various crops throughout the territory represented: Beans, 6,500 acres; sugar beets, 3,500 acres; alfalfa, 2,500 acres; asparagus, 2,000 acres; potatoes, 1,500 acres; barley, 1,500 acres; onions, 500 acres; celery, 70 acres. Considerable areas of orchards were intercropped so that in the above list some lands are counted twice. It is a common thing in the delta region to see beans and other crops growing between rows of young trees or between rows of young asparagus.

The gross value of all crops grown this year is estimated at \$2,500,000 (about 50 per cent more than the entire cost of reclaiming the tract).

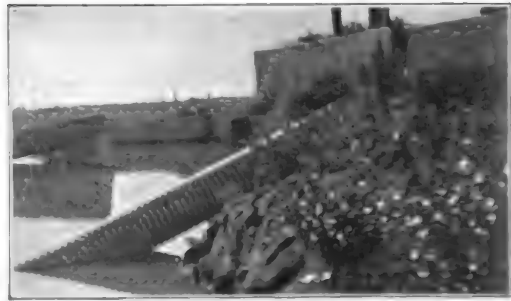
The banner beet grower last year was Mr. N. H. Morton, Clarksburg post-office, who owns 40 acres and farms some rented land. He had 90 acres in sugar beets. A 25-acre field farmed by Mr. Morton produced 26 tons of beets per acre. His average on the 90 acres was 22 tons.

Mr. N. U. Lawlor, who owns 50 acres and grows beets, estimates that he cleared last year \$190 per acre on his beet crop.

The bean crop of the district averaged about 23 sacks per acre, or 2,300 pounds. The average price is probably about five cents. Herringer Brothers, Clarksburg,



One of the huge Armco ingot iron water-tight flumes being installed on one of the great irrigation systems of the far west. As can be seen from the above photograph, this flume connects with the large stone and concrete irrigation ditch shown in the background.



An 18-inch Armco ingot iron corrugated siphon, carrying water from an irrigation ditch in Sacramento Valley, Calif.

grew this year an average of 30 sacks per acre on 400 acres.

Work of U. S. Geological Survey in Past Year

According to the annual report of the director of the fiscal year 1923, the work of the Geological Survey has covered effectively the broad field assigned to that organization, embracing geologic and topographic surveys, the study of mineral deposits, the collection of statistics of mineral production, the measurement of the flow of streams to determine the quantities of water available for use and to provide information needed for projects designed to prevent floods, the study of available ground water, and the classification of the public lands preliminary to the issue of patents or leases. More than 40 per cent of the United States has now been accurately mapped topographically, a large knowledge of its geologic features and mineral resources has been gained, and widely extended studies have been made to discover geologic processes, especially those that determine the accumulation of mineral deposits. Work has been continued in Alaska, surveys having been carried along the Alaska Railroad and elsewhere, surveys of oil fields having been made, and the condition of the mining industry in the territory determined. The work of the Geological Survey has in the past been largely instrumental in promoting development in Alaska.



In the Woolworth Building
Harris-bone lath of Ingot Iron, made by the General Fireproofing Company, was used throughout the world's tallest building to insure permanency. In many of our most prominent sky-scrapers Ingot Iron has been used for window frames, ventilating systems, roofing and other purposes. Wherever long-lasting, rust-resisting metal is indicated there you will find Ingot Iron in use.

ARMCO
.....
INGOT IRON
Resists Rust

The man of many sides who has given America new beauty

HATS off to the American Architect and Engineer; he has done a great work for his country.

He has changed our drab cities into marvels of stone, brick, and marble and sent their graceful spires heavenward in a new school of architecture typical of our time and people. He has housed our industry in palaces of glass and iron dedicated to safety and sanitation.

And he has made the oddly designed residence of twenty years ago a laughable memory.

Beauty that is permanent

Nor does the architect and engineer of today confine himself to the beauty of design; he has a broad and intimate knowledge of materials—he builds for permanence.

If he gets pleasing effects with stone he gets strength as well. He knows brick not merely for its decorative value but also for its endurance. The charm of a grain cannot hide from him the wearing quality of wood.

He is an expert judge of every material that goes into the making of a building—be it skyscraper, factory, or cottage. That is why architects and engineers, the country over, specify ARMCO Ingot Iron wherever special service is required from sheet metal.

For window frames, ventilating systems, roofing, cornices, gutters and down spouts, metal lath, skylights, tanks, stacks—wherever exposure to weather makes dense, uniform, and long-lasting iron desirable, there you will find Ingot Iron written into the specifications.

What ARMCO Ingot Iron is

Ingot Iron is iron from which almost all rust-promoting impurities have been eliminated. It is comparable in purity to the "old-fashioned" iron roofing—such iron as our forefathers made by painstaking hand methods. Owing to this high purity, zinc coating adheres more tenaciously to Ingot Iron than to ordinary sheet metal.

In addition, Ingot Iron is uniformly dense in structure, ductile, easy to work, and it is lasting to an extraordinary degree.

Look for the Armco Label

You can identify articles manufactured of ARMCO Ingot Iron by the blue and gold Armco label. This label is your guarantee of excellence. ARMCO Ingot Iron in sheet form can be identified by the blue Armco triangle, stamped on every sheet before it leaves the mills.

THE AMERICAN ROLLING MILL COMPANY
Middletown, Ohio

Insist on This Date Tag-



INVESTIGATIONS throughout the United States and Canada in which thousands of culvert structures have been examined and photographed, seem to indicate that culverts which bear this tag are the most dependable type in general use.

This is the ARMCO Date Tag, now placed at the upstream end of every ARMCO Culvert—to make identification easy and positive—to protect the service records of ARMCO Culverts from confusion with those of inferior metals.

It is a mark of assurance—proof that ARMCO Culverts are to be judged on their performance in honest competition with those of every other material—an invitation to “look under the roads” in your territory and learn the truth about culvert service and culvert economy.

ARMCO CULVERTS

The HIGHWAY MAGAZINE

April
1924

**Write to the nearest manufactures for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock The Dixie Culvert & Metal Co.	Nebraska, Wahoo Nebraska Culvert & Mfg. Co.
California, Los Angeles California Corrugated Culvert Co.	New Hampshire, Nashua North-East Metal Culvert Co.
California, West Berkeley California Corrugated Culvert Co.	New York, Albany North-East Metal Culvert Co.
Colorado, Denver The R. Hardesty Mfg. Co.	New York, Elmira Highway Products & Mfg. Co.
Florida, Jacksonville The Dixie Culvert & Metal Co.	North Dakota, Wahpeton Northwestern Sheet & Iron Works
Georgia, Atlanta The Dixie Culvert & Metal Co.	Ohio, Middletown The American Rolling Mill Co. The Ohio Corrugated Culvert Co.
Idaho, Pocatello The Burnham Mfg. Co.	Oklahoma, Oklahoma City The Boardman Co.
Indiana, Crawfordsville The W. Q. O'Neill Co.	Oregon, Portland Coast Culvert & Flume Co.
Iowa, Des Moines Iowa Pure Iron Co.	South Dakota, Sioux Falls Sioux Falls Metal Culvert Co.
Iowa, Independence Independence Corr. Culvert Co.	Tennessee, Nashville Tennessee Metal Culvert Co.
Kansas, Topeka The Road Supply & Metal Co.	Texas, Dallas Wyatt Metal & Boiler Works
Kentucky, Louisville The Kentucky Culvert Mfg. Co.	Texas, El Paso Western Metal Mfg. Co.
Maryland, Baltimore (Munsey Bldg.) The Maryland Culvert & Metal Co.	Texas, Houston Western Metal Mfg. Co.
Massachusetts, Palmer New England Metal Culvert Co.	Utah, Woods Cross The Burnham Mfg. Co.
Michigan, Bark River Bark River Bridge & Culvert Co.	Virginia, Roanoke Virginia Metal Mfg. Co., Inc.
Michigan, Bay City U. S. Bridge & Culvert Co.	Washington, Spokane Spokane Culvert & Tank Co.
Minnesota, Minneapolis Lyle Culvert & Road Equip. Co.	Wisconsin, Eau Claire, Madison Bark River Bridge & Culvert Co.
Missouri, Moberly Corrugated Culvert Co.	
Montana, Missoula The R. Hardesty Mfg. Co.	

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Regina, Calgary, Vancouver, Vernon

The HIGHWAY MAGAZINE

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VOL. XV

APRIL, 1924

No. 3



Two Costly and Difficult Road Projects

Above is shown a part of the sand fill for the Gandy Bridge Causeway which will extend across Old Tampa Bay, Florida, and will cost \$2,000,000. It will be four miles long, forty feet wide at the top, and 400 feet wide at the base; while the road itself will be ten feet above the sand fill. A bridge two miles long will span the deepest part of the bay.

\$250,000 per mile will be the cost of the road shown at the right, which is being built by the federal government through San Juan forest in Colorado between Silverton and Ouray. Much of this road, which was the old Uncompahgre Trail, is being cut out of the solid rock of steep mountain slopes.





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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

England to Copy American Roads

WHEN the British Government starts on its road-building plan, which provides for an expenditure of \$11,000,000, in order to relieve unemployment in England, American ideas in concrete road construction will be

largely adopted, P. M. Stewart, head of a British delegation of thirteen, representing 90 per cent of the cement manufacturers in England, recently stated.

Mr. Stewart declared this country was far ahead of Great Britain in road building, but behind his country in house construction. He said this was due to the fact that the British Government had never allowed the building of houses on American lines owing to the fire risks involved.



Paradise Regained

The world was dark and gloomy as he motored down the street,
He'd lost his friends; he had no home;
his plans had met defeat.
One tire flat and punctured and the engine missed on three,
His countenance was blacker than the mem'ry of a spree.
Yet when he pulled into the curb, joy lighted up his face,
And life seemed very sweet again—he'd found a parking place.



A remarkable example of road construction by the early Romans. This road in Rome, known as the Via Appia, was built in 312 B. C. by Appius Claudius Caccus for military purposes. With the passing of time the road became sunken and covered, but when eleven miles of it were uncovered in 1853, it was found to be in excellent condition. And at the present time, more than 2200 years later, it compares favorably with our modern roads. The ruins shown on the left are those of the Ercole Temple and the Villa Quintolii.

Solving the Problem of the Corrugated Gravel Road

By J. L. THAYER, C. E.,

Construction Engineer, Lincoln County, Wash.,
Associate Member American Society Civil Engineers



Corrugations are the bugbear of gravel roads, both to the traveling public and maintenance crews. They have long been the object of many discussions and investigations. Now comes an authoritative explanation of their cause and practical methods of correction and prevention that have proved successful.

GRAVEL roads throughout the country, which have good grades, good alignment and good drainage, are often corrugated so badly that it is impossible to travel them comfortably. Keeping these corrugations out of gravel roads is the big problem in their maintenance.

Some engineers claim that the cause of corrugations is the impulse of motor vehicles. This idea might seem reasonable if all the various cars that use the road had motors of the same impulse time interval, and if the distance between corrugations was the same as that the car travels in this time interval.

Dr. Ladd of the United States Bureau of Public Roads conducted investigations of gravel road corrugations in eight different states for more than a year. In his report on the subject Dr. Ladd states: "The causes of corrugations are:

1. The kick back of surface material arising from the spin of the rear wheels of automobiles as they descend after a bounce over some obstacle or depression;
2. The impact of both the front and rear wheels of automobiles."

A little investigation will demonstrate the soundness of this explanation. The accompanying diagram shows three positions of the rear wheels of an automobile when traveling over a corrugated road. One little rut "X" is all that is necessary to start the action. The wheels in position "A," in order to get out of the rut, must ascend over a little bump. In doing this the friction of the wheel against the surface kicks the binder, or other loose material, out backward in lines marked "M," thus making the rut "X" deeper. In attaining momentum

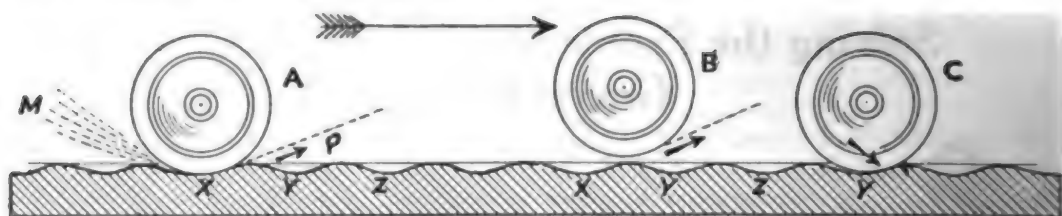


Diagram showing how motor car wheels create ruts in corrugated gravel roads as described below.

enough to climb the little hill or bump in the direction of arrow "P," sufficient momentum is gained to take the wheel clear off the ground for an instant, if the car is traveling rapidly, as in position "B." When the wheel again hits the earth, as at position "C," the impact causes a slight depression which becomes the rut "Y," and as this descent is made, loose material is again kicked out backward.

The action thus described repeated again and again, results in a series of ever deepening ruts, "X," "Y," and "Z," forming the corrugated road surface. As stated in the government report, the front wheels by impact have a tendency to deepen these ruts.

By watching a car traveling at a fair rate of speed, say twenty-five or thirty miles per hour, on a corrugated road surface, it is easy to see the binder being thrown out from under the rear wheels. And by looking closely, one may observe just as plainly that at every bump the rear wheels leave the ground.

What is more interesting to the traveling public, however, than the cause of the corrugations, is the remedy, and though the government report concludes "This problem remains for future solution and must be worked out by a combination of field observations and laboratory tests," there is a remedy which, while not a panacea for all corrugations, if properly applied will do much toward their elimination.

As soon as the frost is out of the surface of the road in the spring of the year, the corrugations should be shaved off by the use of a heavy grader and tractor, or broken up by the use of a scarifier. If a scarifier is used, it must be especially built for the purpose, must have a long wheel base, teeth set close

together, and the member carrying the teeth must be controlled by very fine adjustments. With a heavy grader (three to five tons) pulled by plenty of power, the corrugations usually can be cut off to any necessary depth. The materials thus broken loose by the scarifier, or shaved off by the heavy grader, will add to the loose material with which every gravel road should be covered.

On the ideal gravel road there will be provided a layer of loose, fine material, "a mulch" about three-fourths of an inch to one inch in thickness, which serves as a cushion for travel. The chief summer maintenance work consists in keeping this mulch spread evenly over the surface of the road. This is accomplished by brushing back and forth across the road with a blade machine the fine material which constantly becomes thrown out by travel. When the cushion is in place it acts as the lubri-



A gravel road four years old kept free from corrugations by the maintenance methods described in the accompanying article.



This shale rock road, once badly corrugated, has been put in fine condition through the use of the special scarifier described by the author.

cant separating the wheel from the base of the road, with the result that the minute pit holes filled with fine material do not develop into large chuck holes.

On roads serving five hundred average motor vehicles each day this dressing operation should be continuous, treating every section of the road at least twice each week. A few days' neglect will result in ruts and the beginning of corrugations, which when once formed are difficult to deal with until the surface becomes soft.

Assuming that the road has been properly prepared in the early spring, and that there has been provided a mulch of fine material, a drag on wheels with a long wheel base, or a light grader with long wheel base, is the proper tool to use for the dressing operation. The long wheel base is desirable in order to keep the blade from following depressions and riding over humps. This machine does not need to be heavy, but should be so constructed that there will be very little vertical play between the members of the machine; that is, the entire weight of the machine, as far as possible, should be available on the cutting edges when they are in operation and need pressure. A machine weighing one thousand to sixteen hundred pounds,

thus constructed and having a long wheel base, will be more efficient and more economically operated for the purpose of dressing graveled road surfaces, than a heavier or differently constructed machine.

An excellent example of this method of treatment is found in that portion of Sunset Highway lying between the towns of Reardan and Davenport, in Lincoln County, Washington, which serves throughout the summer months an average of five hundred vehicles each day. This section of highway was constructed of gravel in the year 1915, and by the year 1920 was becoming badly corrugated. Travel was increasing continuously and the corrugations were becoming deeper each season. In the year 1921 experiments were conducted on this road with the result that in the year 1922 the road was treated exactly in the manner above outlined. In that year, 1922, under the heaviest traffic in its history, this piece of road was maintained in better condition than in any year since its construction, and it improved under the travel. At the time the fall rains began, after three months with practically no rain, this road was in the best shape it had been since its construction.

Adapting Old Drainage Structures to Meet New Paving Conditions

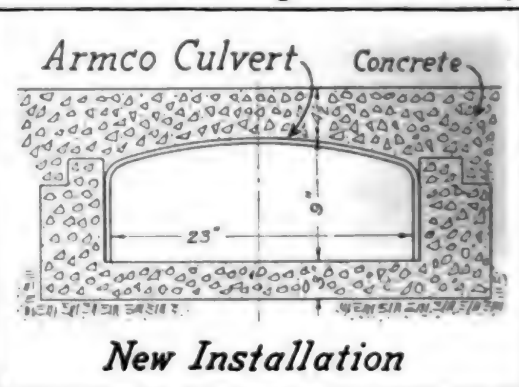
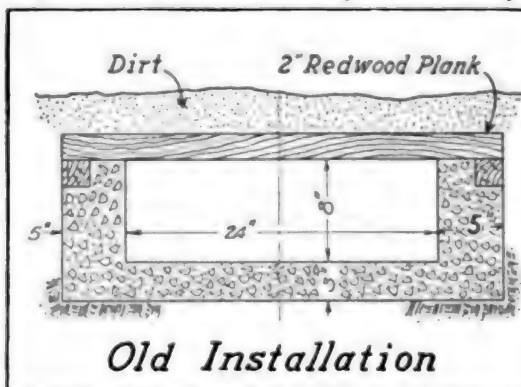
By A. W. COREY,
City Engineer, Inglewood, California

DRAINAGE structures are designed generally to meet the conditions of construction existing at the time they are installed.

Recently, however, in the city of Inglewood, we were confronted with a situation where culverts had to be designed to fit grades as they were designed in 1910. In that year, the city

work was projected, the matter of making these old culverts permanent was the first consideration, and after a study of all economic means of handling this problem, an Armco ingot iron No. 10 gauge special basket shaped corrugated culvert was designed.

Herewith are two cross-section sketches, one showing a culvert as orig-



council of Inglewood graded, curbed and guttered South Commercial street. During this work a series of seven concrete base culverts two feet wide and five inches high with a redwood plank top was constructed. Since that time, these culverts have been repaired and new planking installed whenever the old ones have given way.

In the Spring of 1923 the city decided to pave this street with six-inch pavement and wearing surface. When this

inally constructed and another showing it as remodeled. The two photographs also show the installation of these culverts, which was done by the contractor, W. H. Goff, of Inglewood.

The use of these Armco culverts accomplished two things:

It gave a permanent and satisfactory drainage system.

It was the most economical form of construction that could be adopted.



Two views of the specially designed Armco ingot iron culverts replacing redwood plank top culverts on South Commercial Street, Inglewood, California.

Fighting Forest Fires with Good Roads

By Miller Hamilton,
United States Forest Service



FIRE continues to be the "red enemy of the forests." For the seven years 1916-1922, inclusive, the average annual number of forest fires in the United States stands at 36,100, the number of acres burned at 10,954,137, of which 7,244,000 acres were forest land, and the damage at \$16,463,000 exclusive of the intangible and indirect damage which cannot be measured in dollars. For the National Forests only, the annual average number of fires for the four years 1920-1923 stands at 5,816, the area burned at 337,753 acres, and the damage at \$330,015.

For the calendar year 1922 the number of fires in the entire country totaled 51,891, and for the National Forests alone 6,375; the area burned totaled 11,541,977 acres for the whole country and 373,214 for the National Forests; and the damage amounted to \$16,678,485 for the entire country, and to \$494,965 for National Forest property.

Tentative figures for 1923 are: Number of fires within National Forests, 4,960; acreage burned, 259,399; and damage, \$193,019. For the country as a whole it is believed that the 1923 fire season was not so severe as in recent years primarily because of the compara-

tively favorable weather conditions in the heavily-wooded regions of the Northwest.

Human carelessness continued to be the chief cause of all forest fires, the



This road over Red River Pass in New Mexico, built by the United States Forest Service in 1916, is a fine example of forest highways that have materially aided in reducing forest fire losses by enabling the fire fighters to reach the point of origin quickly.



A railway forest patrol equipped with fire fighting tools and used by the United States Forest Service in the national forests of the West.

number of man-caused fires in 1923 running as high as 90 per cent of the total in certain sections of the country and as high as approximately 80 per cent for the country as a whole.

Within National Forests where man-caused fires in 1923 were responsible for about 60 per cent of the total, incendiary, smoking, and camp fires were the three principal causes, and will continue to be so until public sentiment is aroused against the criminal destruction of timber. Lightning is the principal cause of natural fires. The best methods of forest fire protection thus far proved practical involve the use of strategically-located lookout stations, telephone lines, and mobile forces of fire fighters which can be

rushed fully equipped with tools to the threatened areas. All of these methods depend upon the existence of good roads and trails. The use of airplane patrols is important but has not supplanted the permanent lookout-station system. But all methods of fighting fires must be preceded by basic organization, public cooperation, and sound forestry practices which leave cut over areas free from slash and other inflammable material. No single agency is as important as public sentiment with public cooperation.

Part of the reduction in forest fire losses during 1923 can, no doubt, be attributed to the road improvement in forested sections during the past year and a half, which have enabled fire fighters to move more quickly to the places of origin. Roads to the extent of 2,024 miles and 4,123 miles of trails were constructed in National Forests alone during the past year.

There is a special reason why inhabitants of forested districts should do their utmost to keep forest fire losses down, and that is that not only is 10 per cent of the receipts from sales of timber, livestock grazing permits and other uses of the National Forests expended for forest trails and roads which connect with the main highways, but an additional 25 per cent of such receipts is turned back to counties within which National Forest areas lie for county school and road funds. Better roads mean more productive forests and more productive forests mean better roads.



Colonel W. B. Greeley, Chief of the U. S. Forest Service, and some of the signs used in combatting forest fire losses. These signs are placed along roads and trails in the national forests frequented by tourists.



Illinois Division of Highways Develops New Type Profilometer

By H. F. CLEMMER,
Engineer of Tests, Illinois Division of Highways

Light, easily transported, simple in operation, but extremely accurate in the data it records, the new type of profilometer developed by the Illinois Division of Highways has proved far superior to any other contrivance in testing the smoothness of roads, according to Engineer H. F. Clemmer, who describes its construction and operation in the following article.

IN the development of apparatus for testing of pavements, the Illinois Division of Highways has recently added to its equipment an improved type of profilometer. This instrument, from the results of tests, has proved to be extremely more accurate and efficient in detecting the irregularities of surfaces than the cumbersome and expensive method in which the straight edge is employed.

It was the original purpose of the department in designing the profilometer to construct an instrument that would compare the work of several types of finishing machines, obtain a value that would be an index of the smoothness and riding qualities of any pavement, and furnish a record that could be used in the investigation of such surface phenomena as waving and "hair checking." It has been possible, however, due to the precise nature of the record obtained, to locate the "high spots" on a pavement



Fig. 1. Side view showing profilometer developed by the Illinois Division of Highways as it is being calibrated.

surface with greater efficiency both in time and accuracy than can be obtained with the straight edge method.

Illinois specifications for finished pavement surface require that all irregularities greater than $\frac{1}{4}$ inch in ten feet be chiseled or "bushed" to within the maximum allowable variation and it has been the custom of the state department to locate and remove these irregularities,

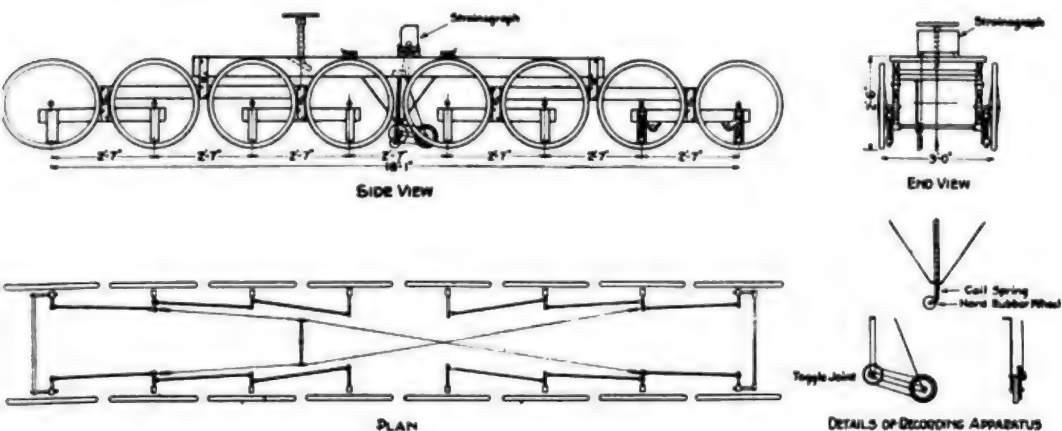


Fig. 2. Drawing showing the details of construction of the new Illinois profilometer.

charging the contractor a nominal sum for this service.

Figure 1 shows a side view of the profilometer as it is being calibrated. Figure 2 is a drawing of the apparatus showing the details of construction. The instrument consists mainly of a carriage frame constructed of wooden members mounted on 16 pneumatic-tired wire wheels and carrying in its exact center the recording devices. These 16 wheels, 8 on each side, are controlled by a steering mechanism so that all pavement, regardless of curves common to highway construction, may be tested with the same ease as straight pavement. The instrument is 18 feet in length from center to center of the wheels and 3 feet in width from rim to rim. It is operated by pushing or pulling in the desired direction, steering being accomplished by a simple control operating all wheels through the desired angle. The record obtained by use of the profilometer is a chart representing the profile of the surface of the pavement over which the instrument is moved.

A recording mechanism shown in Figure 3 is located at the center of the profilometer and consists of a strainagraph equipped with a movable chart. The recording arm of the strainagraph registers any vertical irregularity in the pavement surface and is actuated by a vertical rod about 30 inches in length equipped on the lower end with a hard rubber roller held continually in contact with the surface of the pavement by a spring. A second recording arm actuated by an electro-magnet has been added for the purpose of making special notations on the chart. To call attention to any feature of the record the operator may cause any number of small vertical deviations from the straight line drawn by this second recording arm by operating the electro-recording arm by a push button mounted on the frame. This is an added feature of the profilometer record found to be very valuable in many cases.

The space record, made by horizontal movement of the chart, is obtained by a belt mechanism which drives the pulley on the strainagraph by a pulley attached

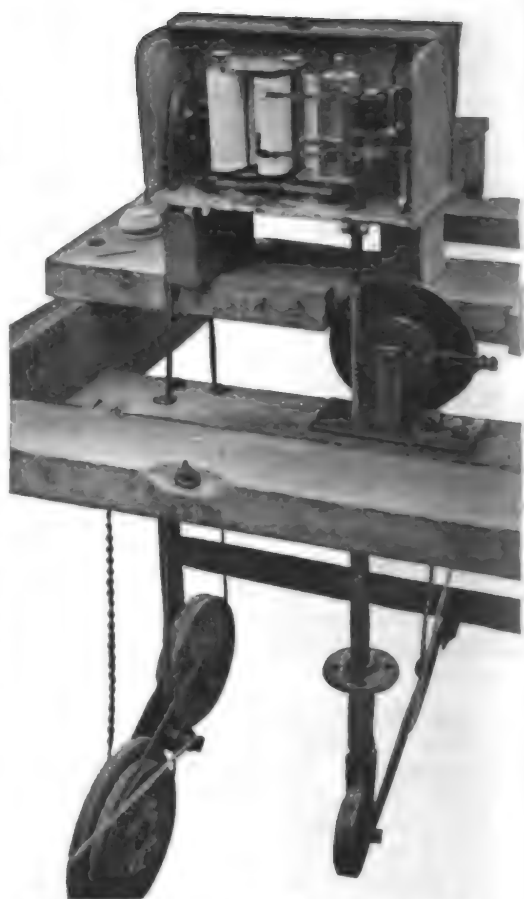


Fig. 3. Close-up view showing the various recording mechanisms of the profilometer which are described on this page.

to a second small rubber tired wheel in contact with the pavement surface. This second drive wheel is mounted on a toggle joint so that it may be raised out of contact with the pavement and horizontal movement of the chart stopped when no record is desired.

A second recording device termed a "totalizer" has been added to the profilometer for the purpose of obtaining an index of the roughness of the pavement. This device consists of a gear and ratchet mechanism, actuated by the same vertical rod used for the strainagraph, which furnishes a summation of the irregularities recorded on the strainagraph chart. This total roughness or summation of vertical irregularities in a unit distance has been found to be a valuable criterion of the riding qualities of any pavement. The figures given be-

low illustrate the possible application of the "totalizer" and the significance of the results obtained by its use.

Riding Quality	Total Roughness
Excellent	.0 — .66 inches per 100 ft.
Very Good	.66—2.19 inches per 100 ft.
Good	2.19—3.78 inches per 100 ft.
Fair	3.78—4.74 inches per 100 ft.
Rough	4.74—9.46 inches per 100 ft.

Preliminary calibration of the profilometer was made on a track of carefully levelled I-beams with the use of obstructions of predetermined dimension. These obstructions were placed in the path of the recording wheel at measured intervals and after several trial records were made of the profile formed by these obstructions, each record was found to check exactly, in both vertical and horizontal movement, the predetermined dimensions. A further calibration was made to determine the magnitude of error introduced into the record by a vertical movement of any wheel in passing over an obstruction. The same obstructions of predetermined dimension were again used and the error caused by a wheel passing over them found to be negligible. This fact is apparent from the construction of the apparatus which allows for the compensation of any error.

The wheels on each side are mounted by coil spring suspension in pairs on four trucks or equalizers. At the centers of these four trucks are suspended the ends of two longer trucks, and to the



Fig. 4. Profilometer on its carrier being loaded into a truck for transportation to a pavement to be tested.

center of these two longer trucks are suspended the ends of the main frame of the carriage. These series of trucks or equalizers act as levers which lessen the error, caused by an obstruction occurring under a wheel, in a geometric proportion having a ratio of 2, so that an obstruction of 1 inch under any wheel causes a movement of $\frac{1}{8}$ inch at the center of the main frame member. Since the recording apparatus is mounted half way between the two sides, this movement is reduced to $\frac{1}{16}$ inch, or an error of 6.25 per cent which is taken care of by the suspension springs.

Since the preliminary tests, the profilometer has been operated over some 25 miles of various types of pavement in Illinois. It is transported on a truck, is loaded and carried by a special frame shown in Figure 4, and may be moved safely to any location desired.

Since the institution of precise surface testing apparatus in Illinois there has been an appreciable tendency toward better finishing of pavement surface on the part of the contractor. This has been demonstrated by the records taken over both the new and previously constructed sections.

In addition to general observations and the records made to check the work of the straight edge which is still being used in the location of "high spots," the Illinois profilometer will be employed in the investigation of surface phenomena such as periodic waving and hair-checking. Due to its accuracy the instrument will also find use in the many experiments now under way or planned by the department.

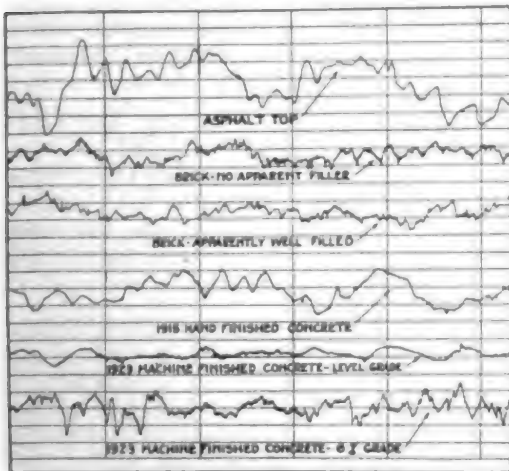


Fig. 5. Profilometer records taken on several types of pavement.

A County Highway Organization That Gets Results

By E. H. COLLINS,
County Engineer, St. Lucie County, Florida

Unusually heavy rains, large areas of low land, with innumerable small bridges, and limited funds are conditions that confront the road builders of St. Lucie County, Florida; yet they have built good roads, and have kept them up. How they have done it is told by the man on the job.



A typical road through an orange grove in Southern Florida.

BECAUSE of the short but unusually heavy rains, resulting in a rapid run-off, a great many original plans must be resorted to in the field to protect the roads in St. Lucie County, one of the leading citrus and trucking centers of Florida.

Traffic on the main highways is at its height from November to April, which fortunately is the dry season. On the Dixie Highway during this period traffic will average about a thousand vehicles per day.

To overcome the unusual difficulties in highway construction and maintenance, an exceptionally efficient county organization has been developed which includes the following essential features:

1. All county highway construction work is performed with county forces and equipment.

2. The county maintains its own central garage and repair plant in Fort

Pierce, the county seat; buys supplies in large quantities; and has all repairs made by the county mechanics.

3. An elastic system of maintenance is in effect. Roads are patrolled and maintained, the maintenance organization being diverted to construction work when occasion or conditions demand, and vice versa.

4. The Board of County Commissioners is the executive head of the Highway department, holding the County Engineer responsible for all maintenance and construction work, all new work and large expenditures being approved by the Board in open session.

5. Commissioner district boundaries are not considered in the planning or authorizing of new road construction projects or unusual maintenance requirements, the needs of the entire county being considered, and all individual cases being judged on their merits.

6. The County Engineer is responsi-

ble to the board, but is unhampered in the exercise of his judgment.

7. The Road Superintendent reports to, receives orders from, and cooperates with the County Engineer, who holds him responsible for the proper performance of all work. The Road Superintendent spends practically his entire time on the roads of the county.

Maintenance of drainage structures has been an important item because of the five large drainage districts within the boundaries of the county, where a great many wooden bridges from ten to one hundred feet in length were built years ago. However, for the past three years Armco ingot iron pipe has been used quite extensively in the construction of culverts, and in the elimination of small wooden bridges.

In the last two years two thousand feet of wooden structures have been replaced with Armco culverts, and it is the intention to continue this policy as far as possible in the future.

Because of the extensive road mileage, the widely divergent conditions, unusually great requirements, and limited funds, economy, particularly in the matter of first cost, is a most important consideration—economy and permanence. Possessing these two qualities, Armco ingot iron pipe to the extent of nine thousand lineal feet has been used in the highway work of St. Lucie County during the past three years. Other figures of interest are the following:

Highway bonds issued by county to date, \$1,185,000.00.

Road building equipment bought by county, \$162,250.00.

Semi-improved roads, 125 miles.

Graded roads, 232 miles.

Marl or clay roads, 71 miles.



A pleasant stretch of the Dixie Highway in St. Lucie County, Florida. More than 50 miles of the Dixie Highway in St. Lucie County are drained with Armco culverts.

Water bound macadam and penetration type roads, surface treated (840,000 sq. yards), 104 miles.

Fifteen and one-half miles of road (Dixie Highway) a state, federal, and county project, is being constructed under the supervision of the State Road Department.

The policy of the Board of Commissioners and the County Engineer has been to develop a system of highways that will best serve the greatest number of people, and water bound macadam has been chosen as the most economical type of road that can be built at present.

Much credit is due the county commissioners, who have proved themselves clear headed business men, broad enough to sacrifice their individual desires for the good of the majority; and to R. L. Hayes, Superintendent of Roads, without whose good judgment and cooperation the present measure of success would have been impossible.



Three types of Armco ingot iron culvert installations in St. Lucie County, Florida. Left: On the Ft. Pierce-White City road. Center: On the Dixie Highway near Walton. Right: On the Dixie Highway near Jensen.

Following the Oldest Roads in the Western Hemisphere

By DR. J. ALDEN MASON,

Assistant Curator of Mexican and South American Archeology
Field Museum of Natural History.

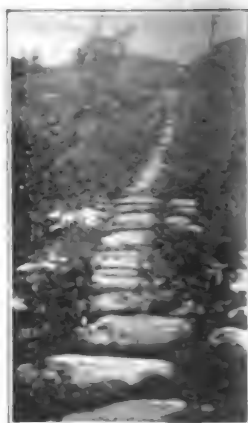


Ancient Indian road
near Santa Marta,
Colombia.

CENTURIES before Columbus hoisted sail on board his little caravel to seek a new way to India, the natives of the elevated regions of the American tropics had, without any influence or example from the higher civilizations of Europe or Asia, evolved the ideal of good roads, and built

the wheel, built their roads merely for runners and foot-travel.

From the early accounts of Spanish conquerors, we have careful and laudatory accounts of these roads. Those built by the ancient Mexicans are not well known in detail, and few traces of them exist today. But it is known that a great road extended



Another old Indian
road in Colombia.

roads, the remnants of which today excite the admiration and wonder of modern engineers.

While the primitive Indian of the United States had only trails through the dense forests, the highly developed military empires in Mexico, Peru and Colombia possessed excellent roads for rapid communication across their territories.

True, as is the case with all superficial resemblances between the Old and New Worlds, when carefully examined, ancient American and European roads differ so in detail of construction and in purpose that it is evident at once that they were evolved separately and without any connection.

Like the famous Roman roads of southwestern Europe and especially of England, these roads were built for the primary purpose of the transportation of armies. The Romans, however, had to build their roads, as roads are built today, with smooth surfaces and slight grades for the accommodation of horse-drawn chariots, while the pre-Colombian Indians, without the horse or any other beast of burden, except the llama in Peru, and ignorant of the principle of

the relay system, fresh fish from the Gulf of Mexico was carried in twenty-four hours to grace the table of Montezuma in Mexico City.

It was in Peru, however, that road-building reached its greatest development and so awoke the admiration of the



Suspension bridge of fibre cable built by the Arhuaco Indians and still maintained.



Remnants of old Indian paving found near Santa Marta, Colombia. Upper left, flagstone street paving in large ancient Indian town.

Upper and lower right, ends of wide paved roads with terminal pillars. Oval, section of road paved with several rows of flagstones.

early conquerors. Wherever the Inca armies went in their conquering sweep, they left in their trail excellent roads by means of which communication could be maintained between the capital at Cuzco and the farthest corner of the empire.

At the height of the Inca Empire, two great roads extended from Quito in Ecuador thru Peru down to central Chile, a distance of between fifteen hundred and two thousand miles. One of these ran through the highlands and passed through Cuzco, the Inca capital. This is one of the most mountainous regions in the world and tremendous engineering difficulties had to be overcome. Ravines were filled up with solid rock, cuts were made in the side of precipitous cliffs and, when necessary, suspension bridges made of fiber cables were swung across deep gorges. One of these bridges is still maintained over a great gorge in the Apurimac River. It is supported by cables made of twisted fiber and vines and is about 150 feet long and 120 feet above the river.

The other road paralleled the coast and passed through great wastes of desert sand and had to be protected from sand storms and drifts. In certain places it was supported on piles, and trees and shrubs were planted along it.

Both roads are said to have been from

twenty to twenty-five feet in width and were paved with flag-stones. Upright stones at regular intervals served as milestones. As in Mexico, at about every five miles there were relay houses at which runners were always in waiting to carry a message post-haste to the next station, and at intervals of ten or twelve miles were rest houses for the convenience of travelers. As the very rigorous social and legal system of Peru prevented an ordinary person from changing his place of residence, travel there was limited to government officials, military forces and the divine Inca as he visited his domain.

The inhabitants of the surrounding regions were compelled to keep the roads in repair so that they were always in perfect condition. By means of them, the Inca, like Montezuma in Mexico, received fish and tropical fruits from the lowland in his high capital within a very short space of time. Today these roads are neglected and only for short sections are they found intact, in most places having been carried away by floods during the centuries of their neglect. Generally no roads have been built to replace them.

Colombia was a third region of high



Santa Marta, Colombia, today. The view at the left shows the irregularity and unevenness of the streets, and that to the right a typical dirt street.

development of aboriginal Indian culture and the land of "El Dorado." Here also roads were built by the natives. In the region of Santa Marta on the Caribbean shores of Colombia, a recent expedition of the Field Museum of Natural History of Chicago, under the direction of the writer, found old roads in great numbers traversing the mountains and foothills formerly occupied by the Indians, but now abandoned to the embrace of the tropical forest. The Indians were exterminated by the Spanish conquerors and their ally, disease, shortly after the time of the conquest, but their roads still attest to their engineering ability and enterprise.

Why these roads were built can only be surmised — whether to keep the trail open and keep it from being overgrown, to escape the tiny ticks which in incredible quantities infest the underbrush in this region, or to provide a hard footing probably will never be proved. Be that as it may, wherever boulders of the proper size and shape were obtainable, the road was paved with one, two, three or more rows of flat boulders, and frequently, a line of upright stones was set on the sides as a curb or limit.

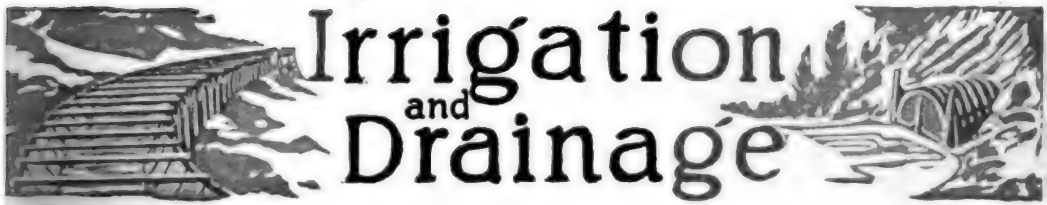
In many places where stones were unavailable, the roads are merely cuts and fills unpaved, but on grades special efforts were made to pave the slope with stones. Sometimes these stones were laid in a sloping ramp, but more often they were arranged as steps or stairs. Having neither domestic animals nor wheeled vehicles, the Indian found a long staircase of slight grade quite suited to his purposes.

In regions near the coast which have

been cleared and reclaimed for cultivation, these roads can be seen extending up and down the rolling or steep hillsides and frequently running up little stream gullies where, due to years of neglect, they have generally been disrupted. But eventually they run into the fastnesses of the unexplored mountains, where they become lost in the tangle of the tropical forest.

Some of the best of these roads are seen in the accompanying illustrations. Generally they are merely a single row of lozenge-shaped stream boulders of approximately uniform size and shape, but often two or three rows with lines to the sides are found. There were even roads of ten feet or more in width, paved with five or more rows and with terminal pillars, as shown in one of the illustrations. In one of the cities visited and excavated, the principal street was found to be eight or ten feet wide and several hundred feet long, paved with carefully-selected natural flat slabs.

These old roads are, for the most part, neglected except where they have been utilized for foot or mule trails. For vehicles the grades are too great. The modern roads of the region are, moreover, sadly inferior to the old Indian roads. In Panama, under the American regime, the streets are asphalted, clean, and a credit to any American city, but in Santa Marta and all the smaller Colombian cities, as shown in the photographs, good modern roads are a dream of the future. The streets and roads are for the most part merely leveled and cleared stretches, undrained, ungraded and unsurfaced. Little is attempted other than the filling up of holes and gullies which form in the surface.



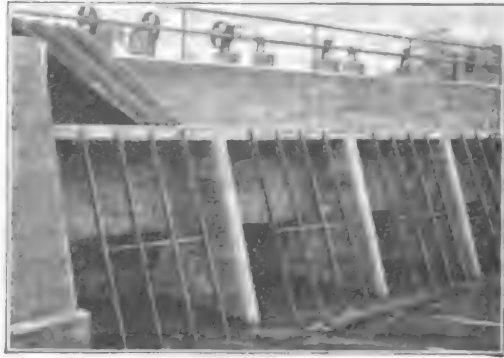
Radial Gates Solve the Problem of Constant Flow Under Difficult Conditions

By C. F. JOHNSON,
Special Correspondent for The Highway Magazine.

Extreme variation in the flow of Kings River and complicated water rights made necessary an accuracy of control practically impossible with the wooden gates first used. The installation of ten radial gates, four of them with automatic control, not only secured uniformity of flow but also greatly reduced cost of operation.

THE Consolidated Irrigation District, located in Fresno County, California, consists of some 155,000 acres. It is situated in one of the richest farming areas in California. Planted chiefly in vines and deciduous fruits, it constitutes a beautiful as well as a highly productive region. Water for this district is diverted from Kings River to the extent of some 300,000 acre feet per year, with a maximum head of 500 second-feet flowing in the canal at the height of the irrigating season.

Numerous districts have prior rights to the Consolidated Irrigation District on Kings River. One of them, the Fresno Irrigation District, has a common



Upstream face of the Consolidated Irrigation Company's headworks on Kings River, California.

diversion point with the Consolidated. The latter company cannot take water



Downstream view of the Consolidated Irrigation Company's dam and gates on Kings River showing Radial gates and automatic control.



An Armco ingot iron flume in service in the Scott Valley Irrigation District, at Fort Jones, California.

until the flow amounts to some 2100 second-feet.

The variation in daily flow of Kings River is extreme, there being as much as one foot in twelve hours, which makes it very difficult to regulate the flow in the canal at the head works. This is due to the fact that the total head diverted by the Consolidated Canal is very small in comparison to the total flow of the river, and a variation of only a few tenths of a foot in gauge height makes considerable difference in the flow of the canal.

At first, wooden gates in concrete headworks were used. These were heavy and awkward to handle, considerable

time being consumed in raising and lowering them. This made the flow in the canal variable, depending on the stage of the river. Even with close supervision a uniform flow could not be maintained.

These conditions, and also the fact that the wooden gates were beyond repair, made it necessary to install a semi-automatic headworks. Ten Calco radial gates, four feet high by eight feet wide, were installed. These gates are of a special design as they are always under pressure — the head varying from four feet to twelve feet. Four radial gates, two on each end, were equipped with automatic regulating devices. These work in pairs, that is, two gates are regulated by one float. The remaining six gates are operated by hand hoists which raise and lower them very quickly. The hoist-operated gates are set for a certain flow in the canal, and the four automatic gates regulate the total flow for a given discharge.

In this manner, the flow in the canal can be kept constant with very little supervision, which results in a great reduction of labor.

This group of headgates, one of the first to be built in this particular arrangement, was designed and built by I. H. Teilman, Chief Engineer of the Consolidated Irrigation District at Selma, California. All of the radial gates are of the Calco type, though of a special design to meet these particular conditions.



General view of the upstream face of the Consolidated Irrigation Company's headworks on Kings River, near Selma, California.



Scene in the Florida Everglades showing lock and dam No. 2, near the outlet end of the Hillsboro Canal.

Draining the Florida Everglades to Make Fertile Farms

By HAMILTON M. WRIGHT

How four and a quarter million acres of useless mosquito breeding swamps, the famous Everglades of Florida, are being turned into rich farm land through one of the greatest feats of drainage engineering in the United States.

THE drainage of the Everglades, one of the most interesting engineering problems being worked out in this country at the present time, as defined by Chief Drainage Engineer, F. C. Elliott, involves two major steps. The first is the lowering of the waters of Lake Okeechobee to a level where they will not overflow the lake's low southern banks and inundate the Everglades, while the second is the draining away of the heavy rainfall from the Everglades themselves. Sixty-six thousand square miles or approximately four and a quarter million acres is the amount of land to be reclaimed.

Through drainage canals, which conduct the water from the Lake to the Atlantic Ocean, the level of Lake Okeechobee has already been lowered about five feet. The principal control canal to regulate and carry away the surplus waters of Lake Okeechobee is the St. Lucie, which finds an exit to the sea near Vero on the east coast of Florida. There are four other main canals. Since practically all of Florida is underlaid by an ancient sea bed of coralline rock,

which frequently approaches the surface, in cutting the canals from the lake to tide water it is necessary to blast away a tremendous amount of this hard rock to secure sufficient depth for drainage purposes.

Lake Okeechobee, whose surface is about 18 feet above the ocean, is situated on a low ridge in the center of southern Florida.

Approximately 30 by 40 miles, it is the biggest fresh water lake, with the exception of Lake Michigan, wholly within the borders of the United States. The rainfall upon a water shed about seven times the area of the lake itself, drains into Lake Okeechobee through the Kissimmee River and other affluents. As the annual rainfall averages from fifty-five to sixty-five inches, and as the rain is often torrential in character, the canals needed in drainage are large.

The St. Lucie Canal, for example, will be 25 miles long, 200 ft. wide, and have a depth of cut varying from 14 to 30 feet. Twenty-one million cubic yards of earth and rock must be excavated in digging it. In excavating the rock holes are

drilled ten to fourteen feet deep, each being charged with about thirty pounds of dynamite. As many as 100 holes are fired at a single blast. One of the problems is to prevent the water that comes as a result of rainfall upon the higher lands nearer the lake from inundating the lower lands near the coast.

A corollary to the drainage of the surplus waters in the rainy season, is the conservation of water for agricultural purposes during the dry season. This is accomplished partly by adjustable dams and spillways along the canals that can be opened and closed as needed. Navigation, also, is served and river boats, launches, and barges ply some of the canals. Many varieties of vegetables are brought down from reclaimed lands near the lake, where the production now exceeds four million dollars annually, by boats plying between Okeechobee and Miami via Lake Okeechobee and the Miami Canal.

The Everglades are not, as so many believe, a vast inundated tropical forest threaded by waterways suggesting scenes at the headwaters of the Amazon. They are, in the main, as their name implies, open glades covered with water and tall saw grass. The water, being the product of rainfall, is not salt but fresh. In spots where a current has washed away the overlying muck, the white marl rock of the old sea bed can be seen. In other places a pole can be pushed down through the overlying muck to the marl bed. There are, it is true, occasional small forested islands, hammocks, or woods along stream banks



Dredger cutting a path through the Florida Everglades.



View of the St. Lucie Canal, the "control canal" for regulating the water level of Lake Okeechobee.

that have been formed by alluvial deposits. These jungles in the great cedar swamp suggest "Amazonian life," but the Everglades themselves are open, much like a Northern duck marsh, except that the sharp-edged saw grass is taller than wild rice.

The total area now used for farming in the Everglades is about one thousand square miles. Scarcely a beginning has been made in the settlement and cultivation of this area, yet the reaction is already felt in the growth of nearby Florida cities. Three sugar mills have been built, and a considerable area is in cane not far from Miami. A railroad 124 miles long, which is expected to be completed by the end of 1924, is being built by the Flagler interests from Lake Okeechobee to Lemon City, a suburb of Miami. It will connect at both terminals with their east coast line.

Most people are aware of the richness of the Everglade land. It is the product of the age-old decomposition of vegetable matter and, as a whole, it is believed to be equal to any semi-tropical river bottom land. The soil, which is a deep bed of rich black mud or muck, produces a great variety of vegetables. Dairying is now successful on reclaimed land near Miami, Lake Worth and other cities.

The reclamation, which is undertaken by drainage districts, each district being assessed for its part of the cost, is in charge of Mr. F. C. Elliott, Chief Drainage Engineer of Florida, to whom great credit is due for the skill with which this great task is being conducted.



Under America's Great Highways

CULVERTS OF **ARMCO** INGOT IRON



TODAY we build with certainty and for permanence. Our great transcontinental highways are planned to bear not only the heavy traffic of today, but also the far heavier traffic of future years.

For fifteen years, under highways and railways, Armco culverts have been watched by officials and engineers—compared with culverts of other types.

Today in many states they are being installed under our great permanent thoroughfares because they have *proved* their economy and durability.

The test of service

Men who have looked under the roads find that Armco culverts give unusually uniform service and meet all the difficult conditions of culvert engineering.

Buried under tons of soil, a culvert must primarily be *strong*. The arch is the strongest of all forms,

and the corrugated surface of Ingot Iron culverts makes a *series of arches* providing maximum strength.

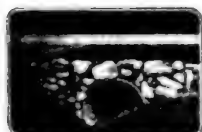
And Ingot Iron culverts are *elastic*. They yield to the terrific pressure of shifting soil and changing traffic loads without cracking. The expansion and contraction of heat and extreme cold cannot damage culverts of Ingot Iron.

Long life of Armco culverts

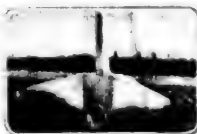
Most important of all, the high purity of ARMCO Ingot Iron makes it more *rust-resisting* than any other ferrous metal. In culverts which are subjected to the corrosive action of various soils, the constant presence of moisture, and the flow of water—the importance of this quality of purity in the iron cannot be over-estimated.

Look for the Armco triangle on every section of culvert. It means long service, low cost, and minimum upkeep.

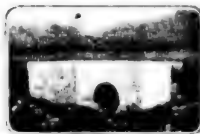
THE AMERICAN ROLLING MILL CO., Middletown, Ohio



Under Park to Park Highway, California—in service for 12 years.



Under National Old Trails Highway, Northern Arizona.



The Backbone Highway, Arizona, showing an Armco installation.



Armco culverts under Yellowstone Trail, Minnesota.



Armco culverts under the Lee Highway and an important railroad.



from a
Road Superintendent's Note Book

July 1907—Three 18 in. ARMCO Culverts installed under Bishop-Big Pine Road.

April 1909—Two 48 in. ARMCO Culverts installed under Bishop-Big Pine Road.

August 1922—ARMCO Culverts under Bishop-Big Pine road examined and found in perfect condition. I estimate these culverts will still be in good condition 20 years from now.

From an actual communication from a Road Superintendent—(Name on Request)

THERE'S just one way to be sure of culvert economy—**KEEP A RECORD OF INSTALLATIONS**—of costs, of repairs, of replacements.



Men who keep such records are finding that:

No culverts of any material prove so dependable—give such certainty of service as ARMCO Culverts.

No culvert material can honestly claim greater "permanence" than ARMCO Culverts.

No culverts seem less affected by time and service than ARMCO Culverts.

Look Under Your Roads

ARMCO CULVERTS

The HIGHWAY MAGAZINE

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May
1924

AMERICA'S
HIGHEST HIGHWAYS
(See Page 14)

**Write to the nearest manufactures for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock The Dixie Culvert & Metal Co.	Nebraska, Wahoo Nebraska Culvert & Mfg. Co.
California, Los Angeles California Corrugated Culvert Co.	New Hampshire, Nashua North-East Metal Culvert Co.
California, West Berkeley California Corrugated Culvert Co.	New York, Albany North-East Metal Culvert Co.
Colorado, Denver The R. Hardesty Mfg. Co.	New York, Elmira Highway Products & Mfg. Co.
Florida, Jacksonville The Dixie Culvert & Metal Co.	North Dakota, Wahpeton Northwestern Sheet & Iron Works
Georgia, Atlanta The Dixie Culvert & Metal Co.	Ohio, Middletown The American Rolling Mill Co. The Ohio Corrugated Culvert Co.
Idaho, Pocatello The Burnham Mfg. Co.	Oklahoma, Oklahoma City The Boardman Co.
Indiana, Crawfordsville The W. Q. O'Neill Co.	Oregon, Portland Coast Culvert & Flume Co.
Iowa, Des Moines Iowa Pure Iron Co.	South Dakota, Sioux Falls Sioux Falls Metal Culvert Co.
Iowa, Independence Independence Corr. Culvert Co.	Tennessee, Nashville Tennessee Metal Culvert Co.
Kansas, Topeka The Road Supply & Metal Co.	Texas, Dallas Wyatt Metal & Boiler Works
Kentucky, Louisville The Kentucky Culvert Mfg. Co.	Texas, El Paso Western Metal Mfg. Co.
Maryland, Baltimore (Munsey Bldg.) The Maryland Culvert & Metal Co.	Texas, Houston Western Metal Mfg. Co.
Massachusetts, Palmer New England Metal Culvert Co.	Utah, Woods Cross The Burnham Mfg. Co.
Michigan, Bark River Bark River Bridge & Culvert Co.	Virginia, Roanoke Virginia Metal Mfg. Co., Inc.
Michigan, Bay City U. S. Bridge & Culvert Co.	Washington, Spokane Spokane Culvert & Tank Co.
Minnesota, Minneapolis Lyle Culvert & Road Equip. Co.	Wisconsin, Eau Claire, Madison Bark River Bridge & Culvert Co.
Missouri, Moberly Corrugated Culvert Co.	
Montana, Missoula The R. Hardesty Mfg. Co.	

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A portable pneumatic striping machine developed by the road commissioners of Wayne County, Michigan, for painting the center strips on highways. The compressed air machine mounted on skids, which are bolted to the truck, sprays the paint on an inch thick strip of felt around a wheel, which in turn transfers it to the pavement. The wheel with the felt strip is two feet in diameter and four inches wide, and is set in a frame fastened to the rear of the truck which causes it to follow the track of the left wheel of the truck. To aid the driver in centering the stripe, the center line is first marked with chalk. With this machine two men can stripe six or seven miles of highway a day, while under the old system four painters striped only about one mile a day.



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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

World Using 18 Million Cars and Trucks

THERE were in operation in the entire world on January 1, 1924, approximately 18,100,000 passenger cars and motor trucks and 1,075,000 motor cycles, calculated on the basis of a compilation made by the Automotive Division.

The world's automotive population at the end of 1923 included 15,763,281 passenger cars, 2,345,850 trucks, and 1,077,935 motor cycles. The total of the three groups was 19,187,066.

In the United States, the approximate total of cars and trucks was 15,280,000, and of motor cycles, 172,000. The more detailed figures are as follows: Passenger cars, 13,484,939; trucks, 1,796,356; motor cycles, 171,568.

The total world registration of cars, trucks, and motor cycles last year was placed at 15,505,788, and the increase during 1923 accordingly was 3,681,278. The registration in the United States at the end of 1922 was 12,567,376, and its growth during 1923 was 2,885,487, or approximately four-fifths of the world increase.

The significance of these figures is best shown in the following comparisons:

The United States has 80 per cent of

all the passenger cars, trucks, and motor cycles in the world.

Out of every six passenger cars and trucks in the world, the United States has five.

In the world, there are more than six times as many passenger cars as trucks. In the United States, this ratio is 7.5 to 1.

The increase during 1923 in all automotive vehicles in the world was 23 per cent, and in the United States the ratio was the same.

The compilation is based upon the best reports received from foreign representatives of the Departments of Commerce and State, which in the cases of some countries were founded upon estimates made by automotive dealers and other sources. These reports were checked against records of imports and sales, figures supplied by the Rubber Division of the Department of Commerce, and estimates made by trade publications.

It is significant that nearly 3,000,000 cars are owned in Pennsylvania, New York and New Jersey, or almost as many as there are in the world, outside of the United States; also that more cars are operated in these three states than any other three states in the United States.

© 1924 HARRIS

Gates Ajar

"IS this the speedometer?" she asked, as she tapped on the glass which covered that instrument.

"Yes, dear," I replied in a sweet, gentle voice.

"Don't they call this the dashlight?" she queried, fingering the little nickel-plated illuminator.

"Yes, honey." My words floated out softly as before.

"And this is the cutout?" she inquired.

"Yes, toodles," as I took my foot off the accelerator. Not more than 200 feet away our course was blocked by a fast moving freight train.

"But what on earth is this funny looking pedal?" she said in a curious tone, as she gave the accelerator a vigorous push with her dainty foot.

"This, sweetheart, is Heaven," I said in a soft, celestial voice, as I picked up a golden harp and flew away.

Three Years of Indiana State Road Progress

By EARL CRAWFORD,

Member of Indiana State Highway Commission.

INDIANA'S remarkable strides in highway progress date from January 1, 1921. From that time until the close of the fiscal year September 30, 1923, the state constructed 387 miles of pavement and built outright or reclaimed more than 3,000 miles of gravel and stone roads. This construction program has been confined to 13 counties, but the reclamation was touched every one. The department's program for this calendar year and 1925 called for building 800 miles of pavement to extend market trunk lines and provide hard surface drives east, west, north and south across the commonwealth. Completion of this program will give Indiana slightly in excess of 1,400 miles of pavement, 1,187 miles of which have been constructed since January 1, 1921. In addition there will be approximately 3,000 miles of stone and gravel roads capable of withstanding modern traffic in all months of the year.

The recent decision of the Supreme Court declaring the increased license fee law void will necessarily delay the completion of the program at least one year and possibly two.

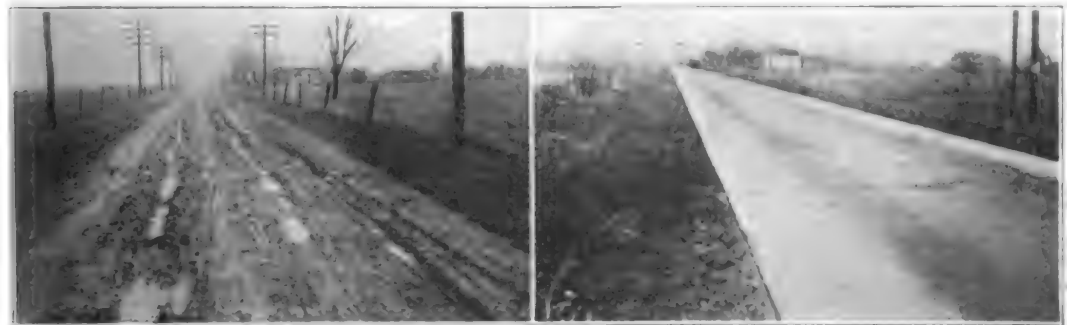


John D. Williams, Director
Indiana State Highway
Commission.

Going back to 1920, the real beginning of the state road system, because most of 1919 was devoted to organization following the department's creation by legislative enactment, and reviewing results accomplished, it is evident that the history of the Indiana state road system in three years is one of intensive development, careful organization and the accomplishment of a vast amount of detailed work necessary to intelligent and systematic expansion.

At the beginning of 1921 the state system was composed of 3,681 miles of roads including 238 miles of pavement. This pavement was disconnected and widely scattered; in the main it was located around industrial centers, because it was built by counties prior to the state system. Today one sees many rural and urban dwellers served by a paved road, because of the broad policy of constructing highways over shortest routes to serve the most people.

Department records show that 1919 was devoted to organization and laying out market highways. Disbursements for that year totaled \$116,020. In 1920 departmental disbursements were \$2,-



An Indiana highway before and after improvement. There is a total of 76,000 miles of road in Indiana, good and bad, and before the development of the present state highway system, started in 1919, it was mostly bad. On the completion of the present program in 1925, however, Indiana will have more than 1400 miles of smooth pavement and approximately 3000 miles of modern gravel roads.



Placing transverse joint dowels at the end of a concrete slab on the Ideal Section of the Lincoln Highway in Northern Indiana.

508,635.16 and the state agency began to systematically maintain highways within its jurisdiction, let contracts and prepare to build a system destined to ultimately benefit every citizen.

In 1919 there were only 200,000 automobiles in Indiana and 7,530,105 in the United States. Since 1919 the good roads of Indiana brought about a total registration in 1923 of nearly 600,000 motor vehicles in the state, while statistics show a national registration of 14,000,000 motor cars. This is a 100 per cent increase for the nation and a 200 per cent increase for Indiana.

Sustained and noteworthy progress in Indiana state highway development began with 1921 when the commission paved 120 miles, reconstructed and rebuilt hundreds of miles of secondary

types and replaced many obsolete bridges with structures adequate to meet the ever growing demand of a new transportation system formulating. Total disbursements that year amounted to \$8,166,121.94. It was this year that the much talked of maintenance costs climbed to a considerable figure because hundreds of miles of narrow, one-way roads were widened, unsafe bridges replaced or strengthened, steep grades eliminated and fills constructed. It is estimated that 33 per cent of all money spent that year by the maintenance division was for actual construction or, in the parlance of the department, "for betterments."

Laying out its construction program toward a definite goal and with the sole idea of serving the most people possible by constructing the shortest routes without expensive relocation, the commission mapped a three-year program and adopted the policy of each year starting paving where it was left off the preceding year. Thus, in 1925, we will have a completed market system of ten or more trunk lines fed by numerous laterals. This trunk line or backbone will connect at the border lines with paved roads of sister states. In this way Indiana is carrying out the program of the federal government, a contributor through extension of federal monies. The federal program calls for approximately 180,000 miles of improved highways, 54,000 miles of which are to be paved on the most important roads of the nation. States now serve in the capacity of units or links in what will eventually become a united overland transportation system more capable of adding prosperity and



Members of the Indiana State Highway Commission who are giving that state a modern road system. They are from left to right: W. G. Zahrt, Ft. Wayne; A. V. Burch, Evansville; Charles W. Zeigler, Attica; and Earl Crawford, Milton, author of the accompanying article.



On the roads in Indiana. The two upper scenes show typical stretches of modern gravel roads as they are being maintained today under Indiana's highway commission. Building roads in the dune country in the northern part of the state requires real skill on the part of the engineer as indicated by the two lower views of dredging operations.

happiness to a people than any other agency now before the public mind.

Profiting from the permanent improvements on some secondary roads made through the maintenance department in 1921—at a time when materials were expensive and labor both scarce and costly—1922's program resulted in paving 117 miles. It was in this year that paving costs were materially decreased and through this saving from original estimates, the commission was enabled to pave an extra five miles without additional funds budgeted to the construction division. Expenditures for 1922 aggregated \$6,491,815.94.

In 1923 fiscal year ending September 30, there was paved 180 miles, including 150 miles of concrete, 7 miles of brick and 31 miles of bituminous macadam. The latter is a tar or asphaltic preparation and costs about \$14,000 per mile providing there already is a good base. Thirty miles of this type road was also built in 1922. This mileage is distributed in twenty counties.

Disbursements in 1923 were \$9,268,770.73.

When speaking of disbursements the figures given include cost of new pavement, maintenance on 4,128 miles now comprising the system, cost of repair

and erection of bridges, erection of guide, information, danger and warning signs for safeguarding traffic, of maintaining equipment for road building and maintenance, cost of motor transport division which cares for a thousand trucks and hundreds of cars—the bulk of this equipment came from the federal government and had to be rebuilt to meet the uses for which it is desired—cost of general administration, etc., etc.

In 1924 and 1925, a construction program planned to complete trunk lines across the state and care for traffic for many years regardless to what degree of density it may reach, bespeaks vision on the part of highway officials and Governor McCray, whose splendid co-operation made possible the state's remarkable advancement in putting Indiana on wheels.

There are 76,000 miles of all kinds of roads in Indiana, this including state, township and county roads. When it is known that 4,128 miles in the state system serves 80 per cent of the total population, then one can readily see that the system was laid out with keen foresight and for the sole purpose of serving the most people possible with the least amount of mileage.

You Can't Get Lost in Wayne County, Michigan

How a system of road signs and highway maps erected at important points on the country road system facilitates automobile traffic in Wayne County.

THE County Road Commission of Wayne County, Michigan, believes in making it as easy as possible for strangers to find their way about the county without the necessity of stopping frequently to inquire.

As a step in this direction they have erected at every road intersection on the concrete highways and at the most important of the gravel road intersections, signs which give the names of both roads, the mileage to the nearest important centers, and often the mileage to the terminus of the road, as well. For instance, many of the signs along M 17, part of the Detroit-Chicago route, give not only the distance to the nearest town but the total mileage to Detroit in one direction and to Chicago in the other.

In addition to these signs the Commission has erected at the point where each important highway enters the

county a large billboard map such as is shown in the illustration. These are complete maps of all the improved highways of the county and enable a stranger to travel almost anywhere without making any inquiries.

A large hand and arrow indicate the exact location of the particular map at which one is looking. These maps are a great help to strangers attempting to go on to a point beyond Detroit because they enable him to take roads which will lead him around the city and avoid the seriously congested area.

Efficiency

Efficiency

"What has become of that bad curve just outside of Plunkville?"

"The town did away with it."

"A good idea."

"Yes, it was cheaper to do that than to build a hospital."



A great help to tourists are these billboard maps, erected at conspicuous and important points, showing the entire county highway system. The map shown above is located where route M 17 enters Wayne County, twenty-two miles west of Detroit, Michigan.



One of the many Armco culverts installed on the Cass Lake-Ball Club project, Theodore Roosevelt International Highway.

Building a National Forest Road in Northern Minnesota

The Cass Lake-Ball Club project, 30 miles in length, constructed at a cost of nearly \$157,000, shortens the distance between the above named towns approximately 15 miles.

ONE of the most notable National Forest Road projects in Minnesota is a thirty-mile section of the State Trunk Highway system and the Theodore Roosevelt International Highway, recently constructed in Cass County in the Minnesota National Forest.

This project is known as the Cass Lake-Ball Club project, after the two towns which it connects, and is the logical continuation of the first national forest road project undertaken in Minnesota by the Bureau of Public Roads, which was known as the Cass Lake Bridge.

In order to construct the Cass Lake Bridge a special appropriation of \$10,000 was made by Congress. To this sum was added another \$10,000 contributed by Cass County.

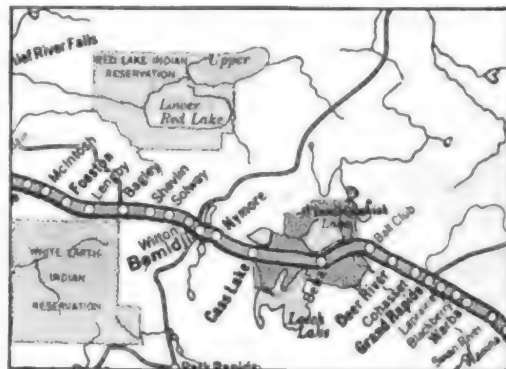
Upon the completion of the bridge another project was taken up for the construction of a road running east from the bridge to connect with an old winding road leading to the east.

After the war the plan was again taken up but in doing so the project was extended in order to reach from the bridge at Cass Lake eastwardly for a distance of about 30 miles to a bridge previously constructed as a Forestry project across

the Mississippi River at the county line near a settlement known as Ball Club.

An approximate estimate of \$150,000 had been prepared by the State several years previously, and based upon this estimate a co-operative agreement was entered into providing for an expenditure for plans and construction not to exceed \$165,000.00. Of the final cost the local authority agreed to pay \$60,000.00 and the Secretary of Agriculture the balance, but not to exceed \$105,000.00.

Under this agreement and in accordance with instruction from the Bureau,



A section of the Theodore Roosevelt International Highway in Minnesota, showing the section between Ball Club and Cass Lake, constructed by the U. S. Forest Service.

surveys, plans and a preliminary estimate of quantities and costs were made. A preliminary estimate indicated a total cost of construction of the project of about \$290,000.00, or more than was available. In making this estimate the project was divided into sections as follows:

A to B, Sta. 10+60 to 141.....	\$ 35,000.00
B to C, Sta. 141 to 807+10.....	107,000.00
C to D, Sta. 807+10 to 1019.....	31,000.00
D to E, Sta. 1019 to Ball Club...	117,000.00
	\$290,000.00

This estimate showed clearly the impossibility of constructing the whole project. The Bureau then outlined what it thought to be the best plan on which to proceed. This was to grade, drain and surface Sections A to B and grade and drain D to E.

This recommendation was made to the District Forester at Denver, Colorado, also to the State Highway Department, with copy to the Forest Supervisor at Cass Lake. It was submitted to the Cass County authorities and approved by them as well as by the State Highway Department. It then remained for the Forest Service Department to approve. The Board of County Commissioners of Cass County was finally given four propositions from which to select, as follows:

1. The County or State to supply the additional funds necessary to construct the entire project.
2. The entire project to be abandoned, liberating the funds for other projects.

3. Construction of the sections of the road from Cass Lake to a point four miles west of Bena. (Sections A, B and C).
4. Construct the sections from Bena to Ball Club (Sections D to E); these to be surfaced with gravel as far as funds will permit.

The County Board passed a resolution accepting proposition No. 3.

The revised plans covered a total distance of 15.09 miles from station at east end of bridge, 10+60 to 807, estimated cost \$145,748.22 for engineering and construction. On this estimate, contract was let to the lowest bidder. The bid for the three sections amounted to \$145,422.16.

The completed project, including engineering and contingencies, cost \$156,577.12.

Armco corrugated culverts 18 to 48 inches in diameter were installed throughout the project. Owing to the sandy nature of the soil in the locality, the entire road was surfaced with clay. The construction of this highway shortens the distance between Cass Lake and Ball Club approximately 15 miles.

The work was completed in 215 weather-working days.

The road is located north of and almost parallel with the Great Northern and Soo Line Railroads, which gives it an added value as an ideal fire break for the forest.

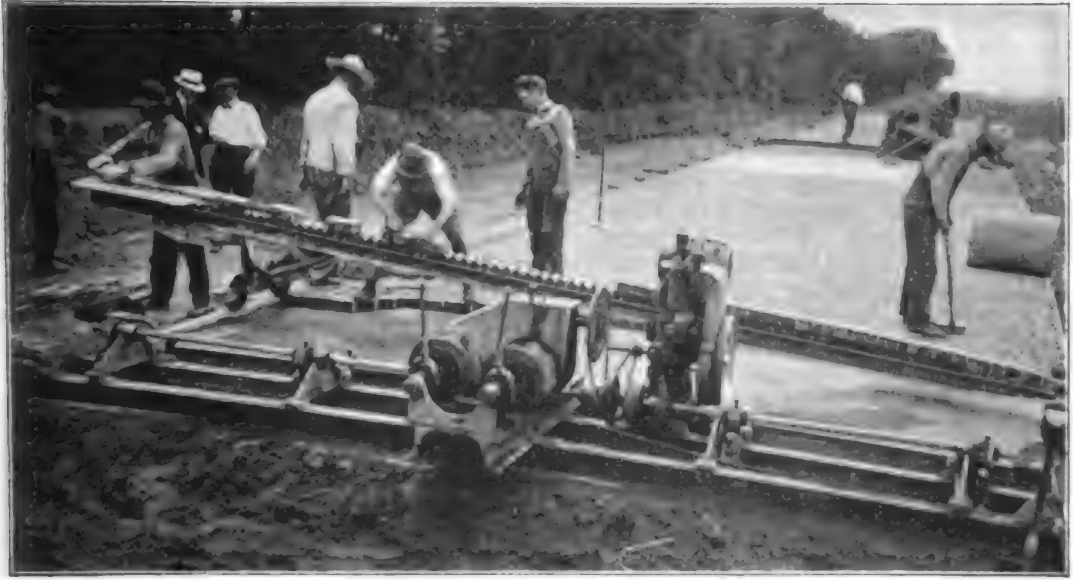


The above scenes show some of the drainage difficulties encountered in the construction of the Theodore Roosevelt International Highway from Ball Club to Cass Lake.

Eliminating Blowouts on Kansas Pavement

By W. A. STACEY,
County Engineer, Stafford County, Kansas.

How a difficult construction problem was solved during the paving of the Old Santa Fe Trail in Stafford County, Kansas.



Laying brick on the Old Santa Fe Trail near Hutchison, Kansas.

ONE of the longest paved roads in the state of Kansas has recently been completed and accepted by the county commissioners. This pavement is 35 miles in length and covers the south branch of the "Old Santa Fe Trail." It begins at Hutchinson and ends at the little town of Sylva, on the Stafford County line. Two types of pavement were used in the construction of this road, the monolithic and the bituminous filled brick, 20 miles being monolithic and 15 bituminous.

Work on this road was started about four years ago. During this time the engineers and road builders of this locality have had some very peculiar experience with the monolithic part of the road. This was a federal aid project, and all the concrete used in this road was made to test not less than two thousand pounds to the square inch.

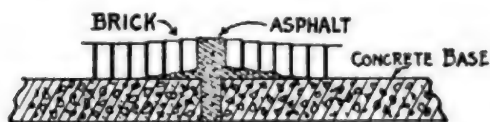
These tests were made every five hundred feet during the pouring of the concrete.

All of the construction joints were

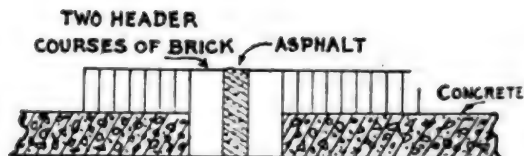
made in accordance with the specifications. In fact, the road was so well built the overseers and contractors felt sure that they were building one monolithic road that would give entire satisfaction.

However, the following summer, after several miles of the road had been finished, the pavement began to buckle, the "blowouts" always occurring at the construction joints. Immediately the engineers and contractors made a thorough and scientific investigation of the blowouts to see if they could locate the cause, and this is what they found. From three to five courses of brick on either side of the construction joints were affected, and pushed loose from the concrete base.

Now this pavement had been built without expansion joints, like other monolithic roads in the eastern states. But after these blowouts began to occur in this road the engineers decided that due to the unusual extremes of temperature in this particular locality even monolithic pavements would have to be



Drawing showing how the asphalt worked between the brick and the concrete base at the construction joints on the bituminous filled brick section of the Hutchinson-Sylvia road in Kansas.



Drawing showing how faults illustrated on the left were corrected.

provided with expansion joints, if the pavement was to give satisfaction.

They immediately began to put in expansion joints at the construction joints, whenever a blowout began to occur. These expansion joints were made two inches wide, running clear through the concrete base; however, they failed to give satisfaction. Blowouts began to occur again right at these expansion joints. Upon taking up these loose brick, which bordered the expansion joint, it was found that the asphalt which had been used as a filler in the expansion joint was very soft on top, but was so firm and solid four inches below the surface that the terrific pressure of the brick, during the expansion of the pavement, had shoved enough of this hard asphalt between the brick and concrete base to loosen two courses of brick.

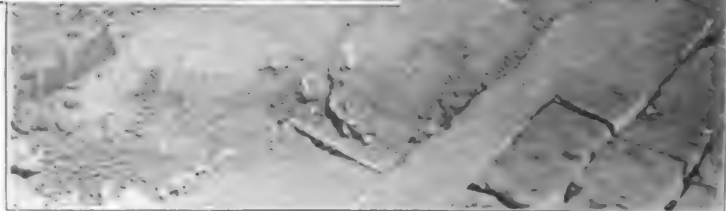
These two courses rising up on one side threw the pressure against the top edge of the next course adjoining them, and so on until a great buckle occurred. The blowouts occurred during the

early part of the summer, after the first real hot days, but later in the summer did not give so much trouble. This was due to the fact that after the asphalt in the joint had become entirely flexible because of the constant summer heat it pushed out at the top of the joint, allowing the brick surface to expand without hindrance.

A method was finally adopted in constructing expansion joints which has given entire satisfaction. In taking up the brick at these blowouts a joint from ten to eleven inches wide was cut clear through the concrete base. Then a header course of brick was run across each side of the joint in the base, leaving a space between the two header courses two inches wide and filling this space with asphalt. These header courses not only keep the hard asphalt from being pushed under the brick, during expansion periods, but the lower ends of these header courses are securely locked, the hard asphalt just above the earth, being between them and the concrete base pressing against them on the other side. This method has been used on this pavement until all of the blowouts have been repaired, and now it is one of the smoothest and one of the most substantial roads in the state.



Two views of failures at the construction joints on the Old Santa Fe Trail, as described in the above article.





A permanent and economically constructed bridge formed by Twin Armco culverts, 60 inches in diameter, on the Black & Yellow Trail, Holabird, South Dakota.

The Importance of Highway Drainage

By H. L. KYES,

General Manager of the Black & Yellow Trail.

POSSIBLY there is not one thing that enters into the success or failure of the modern Road Association as much as does road construction. It is not the purpose of the writer to endeavor to tell the practical road builder, as to the methods of highway construction, nor as to the machinery or material to be used in the construction work. Material must of necessity take into consideration the cost of the road, convenience of material and the amount and class of traffic to be handled. It is only recently that we have gotten away from the old prairie roads, and just a few years back good dirt grades were considered as about the highest ambition of the central and western states. While eastern states had experimented and were still experimenting on gravel, tarvia and hard surface roads, the central portion of our country was satisfied with dirt grades and was building every year thousands of added miles of this style of roads.

With the perfection of the internal combustion motor and the pneumatic tire came hundreds of thousands of automobiles and, incidentally, the tourist. During the experimental stage, traffic by automobile was largely limited to the locality in which the owner lived. However, as he became familiar with his car

and as car construction advanced to a point where practically all cars were fool proof and the possibility of being towed home was eliminated, the automobile owner began to look for added miles of road over which he could "step on 'er." This was first brought about by construction of county highways and the natural result of this was the linking of one county with another. From the start came the conception of State and National Trunk lines, which are now being constructed under competent State Highway Commissions, in connection with the Federal Government, under what is known as Federal Aid Projects.

As these roads became connected one with the other, and trunk lines made available distances of connecting highways, the more progressive citizens in the various towns connected conceived the idea of the modern highway association, to promote the interest of the tourist toward their particular trail or highway. The development of trail associations has been nearly as interesting to those engaged in that line of work, as has been the actual construction of roads. Meetings have been held and millions of words have been spoken and written, telling of the wonderful opportunity the tourist business would bring, and, fortunately, the promises of the



The Black and Yellow Trail from Chicago to the Yellowstone National Park, 1603 miles of highway, crosses many long stretches of comparatively level country where the chief problem in maintenance is proper drainage. Armco ingot iron corrugated culverts have solved this problem to a large extent.

most visionary have been more than fulfilled.

This wonderful new business that has sprung up has developed traffic to a point that has made it necessary to have other than dirt roads and it is demonstrating the necessity for added miles being placed under concrete each year.

It is the particular matter of drainage which I wish to emphasize at this time. The old saying that "a chain is as strong as its weakest link," could easily be changed to "a road is as good as its poorest spot." As long as pressure is used on the chain that does not bring into play the tensile strength of the weakest link, a chain is a good chain. A road may be passable for a distance of five, ten or one hundred miles and one mud hole, by reason of its presence, influence traffic to the extent that towns for miles on each side will be the losers of business. This is an actual condition which exists on all highways and has

proved the advisability of all the towns working through their association to see that pressure is brought to bear in order that that mud hole be removed.

The writer knows of cases where an expensive concrete bridge program was carried on to fix two or three places in a road and the same stretch of road was left impassable, by reason of the absence of six metal culverts. A program of this kind would seem foolish.

Likewise, the writer personally knows of several miles of good dirt road which became impassable by reason of leaving out a 24-inch metal culvert, which would have kept the water off the road and made it possible for the maintenance man to continue his work effectively. Is a program of this kind good business?

On the Black and Yellow Trail we have 1,603 miles of highway, leading from Chicago through to Yellowstone National Park. The highest altitude attained is 9,666 feet above sea level. From Chicago the Trail runs to Milwaukee, thence almost due west to Yellowstone National Park, crossing the richest agricultural sections of Wisconsin, Minnesota and South Dakota, through the Black Hills, or more properly the Black Mountains, on into the short grass country of Wyoming, over the Big Horn Mountains and into the Yellowstone National Park.

The highway is practically all State and Federal trunk lines and our big trouble is, not in getting tourists, but rather in keeping the road passable at all times. This has been by reason of lack of drainage facilities, and the experience of the Black and Yellow Trail Association is merely a repetition of the



The old wooden bridge on the Black & Yellow Trail, Holabird, South Dakota, which was replaced by the twin Armco culverts shown on the preceding page.

experiences of other highway associations.

In one case, where we had a 12-foot bridge, under the new method of construction we now have eighteen 30-inch Armco culverts installed over a distance of approximately forty rods and furnishing much better drainage than the former plan of a single 12-foot outlet.

Incidentally, the land on both sides of the road is now a beautiful hay meadow where formerly there was only an unsightly swamp.

Another case that I distinctly recall is where a matter of four or five culverts near the top of a divide were eliminated at the time of the reconstruction of the highway. The engineer in charge deemed them unnecessary. Heavy rains resulted in a torrent of water filling the inside ditch of the road. This torrent accumulated in force and in quantity as it rushed toward the lower level and, to escape, washed out about forty feet of a fill to the depth of about twenty-eight feet. Men and teams were immediately rushed to the spot and a new fill was made, only to be again washed out two days later. Consider the waste of money as against the small number of metal cul-

verts necessary to have diverted the water down the mountain side, in perhaps fifty different channels. Incidentally, the money expended for extra re-enforcement in the fill, which proved of no avail, by reason of no outlet farther up the slope, would have provided the culverts necessary and the fill would have been sufficiently strong to have taken care of the water that reached it.

The ideal of every highway association is: first, to furnish service; second, to make available points of scenic and historic interest. You, as a highway engineer, as a county commissioner, as a maintenance man, or contractor, have your influence on the service rendered and in no small way have much to do with the prosperity of the towns affected by the different highway associations.

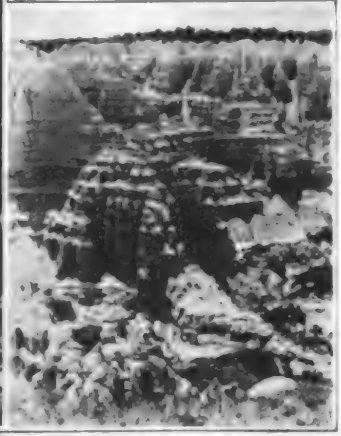
• EDITORIAL •

North Carolina Breaks Road Building Record

NORTH CAROLINA broke her previous records during 1923 by completing approximately 1,053 miles of improved highways estimated to cost in round figures \$22,700,000.



Sights of rare beauty and historical interest along the Black and Yellow Trail. Left: Lookout. "Harvey Peak" in the Black Hills of South Dakota, the highest point between the Rockies and the Alps.



Upper center: A shaded stretch of the B and Y Trail. Lower center: A scene in the "Badlands" of western South Dakota. An effort is now being made to have this region reserved as a national park. Right: Some rugged scenery along the Black and Yellow Trail.

"HIGH"-WAYS

By

Arthur Hawthorne Carhart.

Former Recreation Engineer, U.S. Forest Service



A general view of the Pike's Peak Auto Highway—one of the highest in the world—an inviting challenge to the automobile tourist.

THERE is a sporting element in driving your car over America's ridgepole. The high range roads present a challenge. When the car leaves the last town before the pull over the top there is just a little question about whether or not you will make it without some effort. Even with the fine existing roadways this remains true.

When a car starts crawling over the

colossal backbone of America it must negotiate upgrade roads for miles and miles. The trip on the easiest passes is a test of automobile stamina.

The state of high highways is Colorado. More roads circle and zig-zag to arctic conditions of timberline in this one state than in many others combined.

Passes are the key points on the cross-range roads. The roads lead up, up until the mist robes of the high peaks often scurry around the car. Little snow storms are likely to pay a fleeting visit to the mountaineering motorist on the top of these passes any day in the year.

Of all the roads that climb across the Continental Divide in Colorado, the easiest to negotiate is over Cochetopa Pass. The road extends from Sagauche to a connection with the Monarch Pass section of the Rainbow Route to the westward. This pass of the Cochetopa does not reach timberline. It is 9,998 feet in elevation and good stands of straight timber are on each side of the highest point of the road. Timberline here is at about 11,500 feet elevation. This road is excellent, being patrolled by the U. S. Forest Service. It is open early in the spring and the grades are easy but it tops the great watershed.

Berthoud Pass, west from Denver, is one of the higher passes. It is on the Victory Highway and is used much by tourists. The east side of this climb has recently been put in fine condition



The Wolf Creek Road, a section of the new state road at the lower end of the Box Canyon on the south fork of the Rio Grande, which runs through the Rio Grande National Forest, Mineral County, Colorado.

and there is little difficulty in getting up where the winds whistle around the low scraggy alpine fir trees that hug the ground. Berthoud Pass initiates the autoist into scaling dizzy heights via motor, for one here reaches 11,306 feet above sea level when at the highest point on this road.

One of the most lovely highroads in the Rockies is the Monarch Pass highway on the Rainbow Route. Here one climbs even higher than on Berthoud but the pass is farther south and one does not find such severe timberline conditions. This is the highest highway pass in the state for the altitude is 11,650 feet or more than three hundred feet above any other pass on a main road in Colorado.

There are several other high roads over passes in Colorado. The Pikes Peak Ocean-to-Ocean scales the massive ridge west of Leadville, and starts the swing to the Pacific at Tennessee Pass, an elevation of 11,276. A little used road creeps up over the backbone of the continent from Creede, Colorado, crosses Cebolla pass at 10,394 and follows an angleworm sort of a trail down over the face of the mountain to exquisite Lake San Cristobal and picturesque Lake City. Hoosier Pass is 10,313 feet above the sea at the high point. It is in a most interesting part of the Rockies, north and west from Pike's Peak and near Gray's and Torrey's, peaks which are both higher than Pike's.

A famous mountain highway on the



A steam shovel at work on a road project in the mountains of Colorado.

Old Trail climbs over the top of America at Wolf Creek Pass in the Rio Grande National Forest. Steady improvement is making this mountain road as safe as any but until recently it was a road which demanded real skill in handling a machine in the mountains. The high point on Wolf Creek highway is 10,050. The views from many points on this road are magnificent.

By no means are all of the good roads which climb over high mountain passes on the Continental Divide. There is the Red Mountain road near Ouray which is one of the most beautiful mountain highways in America, the pleasing roads over the Sangre de Cristo range at Veta and Poncha passes and a most inspiring road over the Cucharas pass near Trinidad goes through the center of one division of the San Isabel National Forest.

The Rabbit Ear Road is another example of a very interesting highway not over the top of the Continent but none the less attractive. Recent improvements on the Battle Mountain section of the Pikes Peak Ocean-to-Ocean highway have transformed what was formerly a motorists' nightmare into a much less difficult climb amid magnificent mountains.

There are several projected roads over the high ranges. One at Cumbres Pass near Antonito, Colorado, is under construction. Climbing out of picturesque Conejos Canon it tops the divide just below timberline at 10,003 feet above the sea. Another road over the top is now



Pneumatic rock drills form an important part of the equipment for building roads in the mountainous regions of the West.

being built at Independence Pass near Aspen, Colorado.

Not all of the interesting high highways are in Colorado. Two-Go-Tee Pass in the Washikie National Forest of Wyoming is at once delightful and inviting. Near the high point is Brooks Lake, a lovely water mirror of the mountains.

No comment about highways that reach timberline and above is complete without mention of the famous Pike's Peak auto road. This was built by a private company under Forest Service permit and for the most part is on government land. It is operated by this company as a toll road.

In company with four friends from Boston I recently traveled this highest auto highway.

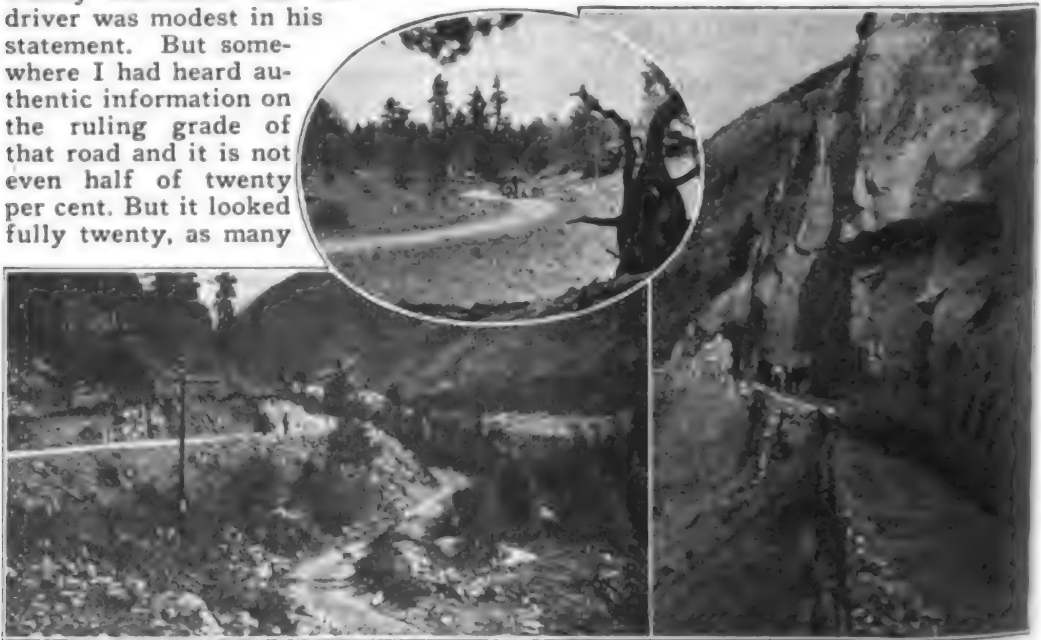
"Now, folks," said our inspired guide-driver in the sing-song of the rubber-neck lecturer, "we approach the worst grade on the whole Pike's Peak Auto Highway. Here is the ruling grade of the whole trip. For a short distance this car will be compelled to negotiate a grade slightly over twenty per cent."

My eastern tourist companions gasped and gazed awe-stricken at the climbing road in front of the car. They were wholly convinced that the driver was modest in his statement. But somewhere I had heard authentic information on the ruling grade of that road and it is not even half of twenty per cent. But it looked fully twenty, as many

of the mountain roads do, and the other occupants of the car were properly impressed.

The highway to the top of Pike's Peak is an excellent piece of road work, which opens up a whole kingdom of mountain scenery to the gaze of the tourist and presents as great a challenge to the mountaineering motorist as can be found anywhere.

There is a fascination in climbing to where one is often enveloped in the lower layers of high clouds or when they are low-hanging the traveler standing on a high ridge looks down to a sea of billowy mist below. Highways to timberline are not common. Practically all that reach above 10,000 feet elevation have been mentioned in this brief story. These old trails over which the pioneers toiled are now broad highways. Not many years ago they were hardly negotiable by buckboard. Today they invite every motorist to climb to the highest point on the road and look down on the vistas of canon, forest and mountains that spread before the eye. Once you try a trip to the top you will become a convert to mountaineering by motor. The highways to the heights will call you again and again.



Highway scenes in Colorado. Oval: Cochetopa Pass on the Cochetopa Pass Highway. Left: The old and the new Berthoud Pass roads. Right: The Old Independence Pass road in the Sopris National Forest of Colorado. A modern highway is now replacing it.

Irrigation and Drainage

Cost of Mississippi River Work

A SUM of \$138,207,795.68 has been spent in improvement and flood control work on the Mississippi River and its tributaries since the creation of the Mississippi River Commission in 1879. During the year ending June 30, 1923, the six districts operating under the Commission were allotted \$5,986,600. To this was added \$1,686,025 contributed by local levee districts, making a total of \$5,125,353.41.

On levee work, \$63,457,365.01 has been expended from government and contributed funds; state and local interests have added \$129,906,930.96, making a grand total of \$193,364,295.97 expended on that character of flood protection in 54 years. Approximately 27,637 square miles of land is protected by levees. A total of



Four 48-inch Calco gates on the downstream ends of four 60-foot lines of Armco culverts under a levee. This type of installation has proved very effective in the flood control work in the Mississippi River basin.

19,670,829 cubic yards was placed in levees during the year and about one-sixth of the necessary content of the controlling levee line below Cairo remains to be completed.

During the year 2,623,810 cubic yards of material were dredged at a cost of \$193,474.69, and the total expenditure of the Dredging District was \$520,401.63.

During the low-water season of 1922 eight dredges were operated in 24 crossings from Morrissons to Waterproof, 70 to 677 miles below Cairo. Dredging was also done in Memphis Harbor, 227 miles below Cairo and at the entrance to lower Old River, 772 miles below Cairo.

The Commission placed 20,302 linear feet of new revetment at a cost of \$1,479,911.79, making a total of 574,574 feet placed at the end of the period.



This novel method of providing strawberries—raising them in barrels—for the northern states during the winter months is in use on an irrigated fruit farm in Florida.

Reclaiming Solano Marsh Proves Big Success

How unproductive duck ponds after having been drained and leached of salt are producing fine crops.

A DEVELOPMENT project that has been under way for the past ten years, which involved the reclamation of about 2,000 acres of tule marsh land on the Cordelia Highway four miles from Benicia, California, is practically completed. The beginning of this work dates back to 1910. The men behind this enterprise are Elven H. Bauman, John Bauman and William Pierce. There are about 2,000 acres in what has been reclaimed, 400 of which belong to Bauman Brothers.

The reclaimed area is in what is known all over the state as a fine duck country, being covered with bullrushes, tule and salt grass. Today the tract is producing fine crops under intensive farming operations.

The reclaimed district extends from Collinsville to Benicia, and is claimed to rival the Delta region of the San Joaquin in fertility. The soil, which is estimated to be 200 feet deep, is the sediment that has been dropped by the Sacramento and San Joaquin rivers for centuries. Properly drained, so as to

leach out the salt that the tides have been depositing, it is evident that the soil is very fertile.

The actual reclaiming is done at a nominal cost as the levees need to be only five feet in height, compared with a twenty-foot wall in many river districts. After the leveling has been done, it is necessary to provide the proper drainage so as to take off any surplus water that may run onto the lands. This is done by Calco automatic drainage gates, which open at low tide and close at high tide.

To hasten the leaching out process, and to reverse nature, in the matter of drainage, tiling has been put in. The tile are located at a depth of not less than five feet, some being eight feet below the surface. They are laid about 150 feet apart, and are crossed by what is known as "gopher holes" which drain the water to the tile. This system keeps the ground dry at all times and puts it in such shape that the heaviest tractor can safely run over it. Before this land was reclaimed it was so marshy that walking over it was impossible in many places. It is now only necessary to pump the drainage water out of the sump for about twenty-four hours a week. To irrigate it, all that is necessary is to open a flood gate on the slough and in a few minutes water can be put on 100 acres.

This reclamation scheme has added many dollars to the value of adjoining land, much of it changing hands for speculative purposes, it being still used for duck ponds. It is quite a contrast to the land surrounding it, which is covered with a dense growth of tule.

This project being on the main line of a railroad, on a state highway and a navigable slough of twelve feet of water, good transportation is available. With the success of this district here is a probable development of about 15,000 acres of productive land, all tributary to Benicia with a possible development of about 60,000 acres in all.



A 36-inch Calco gate in use in a development project in California where many thousands of acres of waste marsh lands are being converted into highly fertile and productive fields and orchards.



The Corrugation Method of Irrigation

A method well adapted for the efficient application of water to steep or irregular slopes.

THE corrugation method of irrigation is a modification of the older and more widely known furrow method.

The principle involved in the corrugation method is that of subirrigation accomplished by allowing small streams of water to flow through a series of narrow, shallow furrows or corrugations long enough to permit the horizontal seepage from adjacent irrigated corrugations to meet, thus resulting in a thorough wetting of the soil between the corrugations, as described in Farmers' Bulletin 1348, Department of Agriculture.

Corrugations are essentially small furrows spaced from 16 to 48 in. apart, depending on the soil type. When carrying the proper stream of water, they are supposed to irrigate the soil thoroughly, principally by a capillary movement of the moisture. Theoretically the stream used in the corrugations is just enough to supply water for uniform absorption on all sides of the corrugation and throughout its length to a depth not greater than the lowest plant rootlets without any waste at the lower end. The length of corrugations and the distance between them should be such as to accomplish this result. Usually the best practice to follow in making corrugations is to have them neither deeper nor wider than is necessary safely to confine the stream.

Shallow furrows are most effectual in spreading the moisture horizontally at the ground surface. In the irrigation of trees and deep-rooted crops, such as alfalfa, the farmer not infrequently uses

deep corrugations with the idea of wetting the subsurface rather than the surface soils, but allows the water to run until moisture shows on the surface. This usually will require a much longer time of application than should be necessary to properly irrigate the crop and will result in a waste of water through deep percolation. Under ordinary conditions corrugations 4 inches deep and 5 or 6 inches wide will be most satisfactory.

The proper distance between corrugations for a particular soil is double the horizontal distance through which moisture will move away from the water line during the time required for the downward moving moisture to reach the maximum depth of plant rootlets. For example, the feeding rootlets of an alfalfa plant extend an average depth of 6 feet into the ground. If the vertical moisture downward is six times as rapid as the horizontal movement then soil



An Armco ingot iron flume which has been in use for more than four years on the East Fork Irrigation District, Hood River, Oregon, and is still in excellent condition.

will be moistened for a distance of 1 foot on each side of a corrugation during the time required for wetting the soil to the proper depth. In this case corrugations should be spaced at intervals of two feet. Lava ash soils have almost the characteristics of blotting paper, so rapid is the horizontal movement of moisture and so far does the movement extend. In very heavy soils this horizontal seepage is so slow as to render the use of corrugations ineffective as a means of irrigation. In sandy soil the downward movement of moisture is so much greater than the horizontal movement that the loss of water through deep percolation prohibits this method. The presence of hardpan or some other stratum which will halt the downward movement of water is a favorable condition for widely spaced corrugations. In general practice the interval between corrugations varies from 16 inches to 3 or 4 feet with the most usual spacing about 20 inches.

In determining the spacing, the irrigator often allows labor and expense to have greater weight than the requirements of the soil. The result is that wide intervals between furrows and slow rates of irrigation are used with consequent overirrigation and a probable development of need for drainage. The simple experiment of running water for different lengths of time through separate corrugations and then excavating a trench across them, ex-

posing the area of dampened soil, will aid the irrigator in determining the proper spacing of corrugations and the length of time that water should be allowed to remain in them for any given soil condition. Since the watering, cultivation and growth of crops very frequently bring about a change in the physical properties of a soil and subsoil, it is advisable to redetermine the proper spacing of corrugations and the proper rate of irrigation after land has been farmed for five or six years.

The length of corrugations varies from 150 to 1,200 feet, but more often they are from 300 to 600 feet. Generally the longer the corrugation, the more inefficient it is in uniformly distributing irrigation water throughout its length, and consequently it should always be as short as practicable. Under ordinary conditions 300 to 400 feet represents good practice, but shorter corrugations are needed for either very steep or comparatively level lands, and it may be advantageous to use longer furrows for soil which absorbs water slowly. On very steep slopes an exceedingly small stream is used in order to reduce soil erosion to the minimum, and this stream will not travel very far before being absorbed. Under such conditions the length of corrugations is limited to 200 feet or less. Likewise for comparatively level land fields must be short to confine streams to the small furrows and water the land in a reasonable time.



A long line of Armco ingot iron flume carrying water along a river bank.



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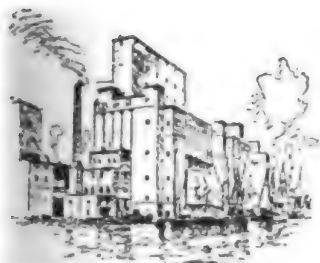
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Look Under Your Roads

The HIGHWAY MAGAZINE



**JUNE
1924**

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No. 5



Traffic of Yesterday

The upper picture shows State Street, one of the principal thoroughfares of Boston in the days when the automotive vehicle was still a hazy dream in the minds of visionary "cranks." Like many other streets of the time, it was narrow, dark, and crowded with horse-drawn carriages and "delivery rigs" that clattered noisily along the pavement.

And Today

The picture below is also of a street in Boston, Charles Street, with long lines of modern vehicles, automobiles, parked along the historic Boston Common on the right and the public garden on the left. Instead of the clatter of horses' hoofs and the rattle of steel-rimmed wheels, there is the purr and muffled cough of engines, as beautiful steel lined bodies glide swiftly by on rings of rubber cushioned with air. It is a picture of traffic on the streets of today.





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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Road Maintenance Expenditures

EXPENDITURES for highway maintenance are reaching huge proportions. Some of the older eastern states already spend more annually for upkeep of old roads than they do for building new roads. Throughout the country the practice is the reverse. The vast majority of states have only begun the construction of the improved roads which traffic requires. Their construction account looms large not only in actual figures but in the concern and consideration of the people. These facts have served to overshadow in public thought the growing magnitude of the public-road-maintenance business. It is growing up unobserved. Excluding interest on funded debts for road construction, about 40 per cent of the present expenditures for highways is for maintenance. This percentage is based on the latest complete records of 1922. They are worth noting. According to the Bureau of Public Roads the highway expenditures for 1922 were \$617,000,000 for construction and \$245,000,000 for maintenance. About 30 per cent of all maintenance expenditures are for the 220,000 miles of state-system highways, which are less than 8 per cent of the total mileage of all highways. The point

to be given attention, however, does not lie in refinement of analysis, which the general figures available do not justify, but is the magnitude of the total maintenance expenditure. This puts highway up-keep among big business operations. It needs remembering too that it is a continuing business and a growing business and the part of the highway business most in danger of coming under political direction unless the situation is made clearly known to the road-using public.

Fifteen Thousand Killed in Highway Accidents in 1923

EVERY 28 minutes, during the last year, a person was killed on the highways of the United States and each time 2.5 minutes were ticked through, some person was injured.

Highway accidents claimed 15,000 lives and caused 1,700,000 injuries. The death rate from automobiles has increased from approximately nine deaths to every 100,000 of population in 1917, to 13.6 per 100,000 in 1923.



One of the numerous Armco ingot iron culverts installed under the many miles of scenic modern highway that have been built in Arizona. This type of installation helps keep maintenance costs to a minimum.

The Apache Indian • Master Road Builder

by
Ward R. Adams



THE Apache Indian of Arizona was North America's first good roads advocate. More than that, he was its first good roads builder.

How many centuries ago his good roads building program was carried on, historians have been unable to determine with any degree of accuracy. But they are agreed—and there are some undeniable evidences—that it was long before Columbus made his momentous voyage. These roads have endured through the years. They still remain in an excellent state of preservation.

The Apache has handed down to posterity road building ideas that Arizona highway engineers have incorporated with no little degree of success — ideas, singularly enough, that the Apache alone, as a race, is able to practice.

In Arizona, where highway construction is perhaps more of a problem than in almost any other state, the Apache has become an almost indispensable part. His genius and his labor have made possible the construction of many good

roads that otherwise would not have been built.

Arizona, in building roads, has to deal first, with cost; second, with labor; and, lastly, with materials. The cost probably is the most important of the three. The vastness of the state itself, coupled with a correspondingly small taxable wealth, makes financing of road building programs a real problem. Weather conditions, especially in the central and southern portions, are such that the labor problem is an acute one during some months of the year. The white man cannot be induced to remain on the job under any circumstances, so the builders are obliged to turn to the more hardy races — those of darker skin.



Chief "No Shirt," famous Apache scout who aided the engineers in locating the Apache Trail.

The cost of moving modern road building materials to scenes of construction, especially in the more remote sections of the state, is prohibitive and wholly out of the question. It is necessary to use materials at hand.

In the modern scheme of things, as in the old, the Apache has played a leading part in the highway building pro-



A view of a section of the Apache Trail Highway showing an excellent example of dry rock masonry built by the Apache Indians in 1906.

gram in Arizona. He built, under direction of white engineers, the first good road ever constructed in the state—a road from Phoenix to the Roosevelt dam-site in the Sierra Ancha mountains 80 miles to the east. This road which was constructed for the purpose of providing a means for moving building materials to the Roosevelt dam-site, is known as the Apache Trail highway and is now considered one of the most famous of all scenic highways in America.

Through 40 miles of mountains, this road has been hewn out of solid rock or built up above canyons hundreds of feet deep. The modern highway practically follows the original trail of the Apaches through these mountains. The grades have been modified in only a few instances. A natural engineering genius enabled the Indian to "catch" a proper grade by eye just as accurately as they were able to do with instruments, engineers declare.

The trail pierces into the heart of the old Apacheland. It follows along canyon walls where the traveler looks down into chasms many fathoms deep. At the

top of Fish Creek canyon, one of the famed vantage points of the trail, the motorist gazes into a valley of peace and quiet 4,500 feet below.

All this was made possible through the labor of the Apache Indian and his prehistoric methods of highway building, for engineers are agreed that if the government had been obliged to resort to modern methods of road building, the cost of construction would have been prohibitive.

The dry masonry work of the Apaches,—as shown on the front cover and the accompanying illustrations — put down in 1905, still serves the highway. Not one penny has been expended on repair work of this masonry, according to statistics of road maintenance costs on file in the office of the Water Users' Association at Phoenix. This organization maintains jurisdiction over the highway. The masonry work has outlived three road surfaces and is good for many years to come, engineers assert. It has outlived the concrete and steel work on the highway many years.

In the selection of materials for use in this dry masonry work, the Apache Indian is an expert without a peer. He picks his rock from the mountainsides as readily as if it had been carefully selected for him and he never errs. No cementing material is needed to insure solidity, so near perfection is he in his art.

Much of their ability as dry masons has been acquired through environment,



Fat-Hen, an Apache Indian, and his team of mules employed in the building of the Apache Trail Highway. To him and his tribe Arizona owes many of her good roads.



A group of Apache Indians at work on the Apache Trail Highway during its construction in 1905-06. But for the tireless work and great ingenuity of these Indians, the highway which bears their name and many other roads in Arizona would not be the joy to the tourists that they are today, in fact, many of them would not yet have been built.

Indian students say. They have always lived in surroundings where there were outcroppings of rock formation. Their forts were of rock; their fences, what few they had, were of rock; so were their dishes and their weapons of war. So the Apache comes to his art naturally.

But there's still another side to the Apache, aside from his skill. It is his pride in his work, and that makes him of greater value to the engineer. He is zealous of his workmanship and can be trusted to "carry on" just as faithfully under one condition as another.

The Apaches are a hardy race, among the most hardy of all Indian tribes. That makes them particularly valuable in highway building in Arizona. They work just as tirelessly during the hot summer months as in the winter.

Likewise, the Apache is the most independent of all Indians, even more so than the Yaqui. He is energetic and enterprising, and, above all, a hard worker. He is not a fast worker, but what he does he does with an exactness that is well-nigh perfection in itself.

As a result of his enterprise, the Apache is "on his own" now, at least a big majority of those within Arizona. He no longer is a government charge. He left his reservation nearly 20 years ago, when the opportunity to earn his own way first presented itself, and he

has continued to administer his own affairs since.

It should be understood that the Apache people are by no means a nation and never have they been held together in any particular bonds of national or political union. Within Arizona, the principal bands include the Chiricahua, Pinaleno, Coyotero, Aravaipa, Tonto, San Carlos and a few others.

The word "Apache" is understood to have its origin in the Zuni word for the Navajo, meaning simply "enemy."

As to the working qualities of the Apache, General Crook, who for many years conducted the government campaign against these tribesmen, once wrote:

"I have come in contact with almost every tribe of Indian, but have never seen the equal of these Apaches. They are absolutely indefatigable and do not seem to tire. They live on food that we would starve on. They will travel a hundred miles a day over the roughest country imaginable."

This energy, directed in the right channels, has made of the Apache an asset that is indeterminable. Today he is a highway builder, building as he did a half century ago. He is Arizona's most valuable labor asset for highway construction. Many of the state's most scenic highways would still be rough mountain trails were it not for the ingenuity of his efforts.

How Ohio Builds and Maintains Highways

By G. F. SCHLESINGER
Ohio State Highway Engineer

In Ohio where there are approximately 1,000,000 motor vehicles, or about one to every six inhabitants, some particularly difficult problems confront the state department of highways, which has built about 5,500 miles of highways during the past ten years. The general policy of financing, construction and maintenance is outlined in the following article.

WHAT are the fundamental duties and functions of a modern state highway department? Do they consist of the construction and maintenance of roads?

Important as are those duties, they are, in a way, only incidental to the main purpose of the department, that of taking care of traffic on the highways. At two recent meetings of state highway officials the idea of traffic service to the motor travelling public was the predominating thought.

A most important item in providing service to the motoring public is the minimizing of the time that an inter-county highway is out of service to the travelling public. To accomplish this will require the best efforts of the personnel of the highway department from the Director down to the laborer on the road. While important roads are under construction detours must be provided, often at a considerable expense. In fact, the total estimated cost of an 8-mile detour in a 5-mile project with an average daily traffic of 1,000 tons for a six

months period, considering cost of operation, time lost and maintenance of detour road, is over \$130,000.

The time that the travelling public will be deprived of the use of a road under construction is vitally affected by the judgment of the Director of the highway department in awarding contracts, for it is the director's duty to examine carefully the experience, financial ability and general reputation of a contractor before awarding him a contract. Unfortunately, due to criticism that has emanated from non-technical sources, the directors in the past have not felt entirely free to select the best bidder, if he happened not to be the lowest bidder.

When detours are necessary they should be maintained in a serviceable condition, and be well marked. To this end the department last year decided to participate with the counties in the maintenance of detours. At present an item for maintaining detours is included in the estimate of the cost of the project and finances must be provided for the same.

The main difficulties of the Department of Highways and Public Works of Ohio arises from (1) the system of financing projects and (2) the diversity of types of pavements used in construction.

The construction of state-aid roads is a matter of agreement and co-operation between County and State officials. They must agree on the location of the improvement, the division of cost between County and State, the types upon which bids shall be received, and the time of the letting. So far as the state's share of the finances is concerned it is a pay-as-you-go policy; therefore, the state



The Eaton-Canada road in Public County, Ohio, an excellent example of the progress made in that state in the building of hard surface roads.

has no bonded indebtedness for the construction of roads, and the continuance of the construction of state roads has not depended upon the periodic approval of a large state bond issue by the voters.

The varied types of pavement constructed on the state roads of Ohio is a matter of comment not only among highway engineers of other states, but of our own state as well. However, this is largely due to the fact that we are really making use of local materials that go into the manufacture of various paving products and types of construction.

If a north and south line, passing through Columbus is drawn on the geological map of Ohio it will be found to divide the state into two general varieties of surface structure. West of that line are the deposits of limestone in which are located our commercial stone quarries. East of the line the formation consists of shales and sandstone, both of which are used as paving materials.

The sandstone is used in its native state for foundation courses, and the shales provide the raw materials for the manufacture of vitrified paving brick. Ohio leads the nation in the production of the latter. Limestone and shale are both used in the manufacture of Portland cement, and hence it is natural to find the existence of several cement mills in the state. Then, too, Ohio is one of the leading states in the steel industry, and the bi-product of the blast furnace known as "slag" is used extensively in road construction. This can also be used as an ingredient in the manufacture of Portland cement.

In the western and northern parts of the state there are large quantities of sand and gravel, and along the Ohio River on the south and Lake Erie on the north are supplies of these same materials. Tar, being a by-product of coal distillation, is also manufactured to some extent in this state, while the largest deposit of native rock asphalt is in our neighboring state of Kentucky.

This abundance of road materials, while a blessing to the state, also results in the difficult problem of deciding on the kind of material to be used.

When the state aids in the improve-



A brick paved road in Ohio, one of the many types of modern roads built under the direction of the Department of Highways.

ment of a road it is obligated to maintain it up to the limit of the funds appropriated by the legislature. The present maintenance and repair funds obtained from the automobile license fees are entirely inadequate to take care of the straight maintenance and replacement work that should be performed on the State System. The writer is in favor of a tax on gasoline used in motor vehicles. Not because 37 other states have it; not because Ohio, although second in number of motor vehicles, ranks forty-second in revenue per automobile used in road work; but because it is a tax on those who get service out of the roads, it is a tax on those who create the necessity of maintenance; it is a meter tax that is proportionate to the benefits derived; it will be a comparatively popular tax due to the manner of its payment; it will tax out-of-state users of our roads; the cost of collection will be negligible; and finally it will make possible the proper maintenance of our state roads without curtailment of construction.

The Division of Highways is keeping in close touch with, and adopting when it feels justified, the latest developments in the design of pavements. It believes that the design of sub-grades is also assuming a great importance, and to this end is co-operating with the Bureau of Public Roads and Prof. Eno, of Ohio State University, in sub-soil investigations.

Tourists' Camps Along the Nation's Highways

By PAUL THOMPSON

Special Correspondent for The Highway Magazine

General prosperity and the genius of manufacturers has placed the automobile within reach of the average man, and the building of thousands of miles of good roads reaching almost every part of this great country has made it a pleasure to use them. Each year a vast throng of recruits is added to the great army that tours the highways, camping by the wayside whenever and wherever it suits their fancy. How some communities are handling the problem of providing camp sites for these automobile tourists is described in the following article.

THE Covered Wagon has made its last rumbling journey over the rough winding trails that once led west. The west was then the land of promise, the land of adventure. Many privations and the continual threat of death at the hands of Indians followed the hardy pioneers in the canvass covered "prairie schooners" as they crawled slowly forward under the spur of Westward Ho.

Again move great caravans, but not in wagons rumbling slowly along tortuous trails blazed by some adventurous pioneer, but in speedy, comfortable modern automobiles that travel as far in a few hours as the old vehicles did in a week. Clearly marked, smooth surfaced roads designed by modern engineers have replaced the rough uncertain trails.

Good roads and the automobile have enticed America out-of-doors, and each year the number of those who start out

on an automobile trip to enjoy the open and camp wherever they find an inviting spot increases.

Scattered along the main highways of this country are now more than 1800 camps maintained exclusively for automobile tourists. Some of the camps are private ventures where the tourists pay a fair price for the accommodations provided, and some are maintained by cities either free, or at a nominal charge to pay for the services of the caretaker.

A fine example of this latter class of camp for accommodating the wayside motorist is the one maintained by the City of Kansas City, Kansas, about a mile west from the business district of the city on the National Highway. This camp, whose upkeep is provided for in the budget of the Park Department, comprises about five acres and will accommodate about five hundred cars and twelve hundred people at one time. As a car enters this camp, which is surrounded by a Page Protection Wire Link fence, an attendant, who is on duty at all hours, obtains the names of the occupants, their destination, and other details for the department record. He in turn furnishes any maps and information that the tourists may want. Within the grounds the tourists will find fire-proof buildings rest rooms, kitchen and laundry. The kitchen and laundry are fully equipped with modern electrical conveniences.

In many cases, however, the tourists' camps are merely enclosed sites free to the use of the wayside motorist and to which he is guided by conspicuous signs along the highway. The camp site in



Brackenridge Park, San Antonio, Texas, showing the municipal camping ground provided for the automobile tourist.



Camp Grande, the \$100,000 "tourist town" at El Paso, Texas, where the old Spanish Trail enters the city from the east. There are twelve "bungalowette" buildings, stores, shops, and room for tents.

Brackenridge Park provided by the city of San Antonio, Texas, is an excellent example of this type.

Automobile tourist travel has reached enormous proportions. According to the report by the Jacksonville Motor Club, of Jacksonville, Florida, more than 100,000 of them entered that state last year, and a big increase in this figure is anticipated for 1924. Many other states can show similar or even larger figures.

With the movement of this great army, the question of sanitation has assumed real importance. Unlike a military army, there is no commanding officer, no set of regulations, and no sanitary corps; and, unfortunately, there is always a certain proportion, small though it may be, of people whose conception of sanitation is very primitive. They are a constant menace to a community where modern sanitary codes are not strictly enforced. In Wisconsin, where good roads, innumerable lakes, and wooded areas attract many thousands of automobile tourists during the spring, summer, and fall, a great many tourist or summer camps have sprung up during the past few years. Fortunately that state has one of the best sanitary codes in the United States with efficient state health and sanitary departments for enforcing their regulations.

In general the sanitary provisions in summer camps must pass inspection by state sanitary inspectors.

There are literally millions of pleasure car owners in the United States. A

large proportion of them are going to make one or more trips or tours during the coming year. They will all spend some money, some of them a great deal, and not a few of them are prepared to buy property or make business investments where they find something that appeals to them. Where they will go, where they will spend their money will depend largely on two things—good roads and a friendly reception. Clean, attractive, well kept campsites where they may also make purchases of supplies at reasonable prices will go a long way in establishing a friendly feeling.



An Armco ingot iron culvert installed under a road near the Northern Pacific right-of-way, in Powell County, Montana, the heart of the nation's playground in the Southwest. It is but one of the many thousands of similar installations draining the highways that have made automobile touring popular.



ROADS OF

By Russ

Director Amer

MILES and miles of good hard roads lined with oak, black walnut, hickory, elm, maple and many other varieties of trees breaking the force of the wind in winter, shading and taking the glare of the sun from the roads in summer, announcing with their varying shades of green the arrival of spring, and presenting in long panoramic views the gorgeous beauty of turning leaves in fall, will become an actuality in this country if the plans of the American Tree Association and a host of other organizations and individuals are realized. Good roads will then also mean beautiful roads.

Although this movement for lining the highways with trees is only in its infancy, thousands of trees





REMEMBRANCE

Edwards
Tree Association

They have already been planted along the roads throughout the United States. The Women's Club of York, Pa., on Memorial Day dedicated a twenty-five mile Road of Remembrance on the Lincoln Highway. Trees have also been planted along many other sections of the Lincoln Highway and other main roads by Women's Clubs, Rotary and Kiwanis Clubs, Chambers of Commerce, historical societies, banks, American Legion posts, and individuals. America's highways are rapidly coming the best in the world, and the enthusiasm with which the country is responding to the demand for the planting of trees, indicates that in time these highways will also be the most beautiful.



Wisconsin Builds Gravel Roads Economically

By H. J. KUELLING

Construction Engineer, Wisconsin Highway Commission

Nature supplied the state of Wisconsin very liberally with gravel, and the road builders of that state have used this material freely in the building of an excellent system of highways. They have developed methods of preparing and handling the gravel that have kept the cost of constructing and maintaining roads at a very low figure, which are fully described in the following article.

WHILE Wisconsin is quite well known as a builder of concrete highways, she probably deserves more credit as a builder of gravel highways. It is quite natural that she should use the material with which nature has bountifully endowed her. For the thousands of miles of gravel road construction in the state, there are very few cases, indeed, where gravel has been shipped in. In fact, the shipped material amounts to only a small fraction of one per cent, and it is seldom that the hauling exceeds a few miles. Occasionally long hauls are made in winter on sleds when large loads can be moved, even up to six or seven yards to a sled. These hauls are generally over sandy soils that do not permit good summer haul.

Gravel deposits in the state run from



One of the many good gravel roads in Wisconsin. Gravel is plentiful in this state and the highway engineers have used it liberally in building an excellent system of hard roads.

mammoth deposits over a hundred feet in depth in some parts of southern Wisconsin to deposits only one or two feet in depth in some of the less favored sections; and the gravel itself varies from very clean, fit for concrete without washing, to gravel having too much clay for even gravel road construction. It varies also from very coarse, requiring a large amount of crushing, to gravel so fine that it can be hauled from the pit to the road surface.

Wisconsin gravels are almost entirely glacial, although there are some river deposits of value along the larger streams. In the southwestern portion of the state no glaciation took place; hence there are no gravels to speak of. In this section there is being developed a road consisting of finely crushed limestone which is treated as a gravel road, being constructed and maintained as gravel is in other sections of the state. In still other sections disintegrated, or rotten, granite or gabbro, is used as a gravel and makes excellent riding roads. Whether or not crushing is resorted to depends upon the extent of disintegration.

In fact, it has almost become a policy in Wisconsin to have no particular gravel specifications as to grading of sizes, except the maximum. A road is built of the best and most convenient material available, or, in other words, the most economical.

In order to determine the most economical material, the material department sends out geologists to locate the available materials within reasonable haul of the jobs, providing entirely satisfactory deposits are not already known. In making the selection of the deposit or deposits to be used, due consideration is given to physical condi-



Portable equipment used in the building of gravel roads in Barron County, Wisconsin. This type of plant is now being replaced in many sections of the state by more modern outfits as shown on the next page.

tions of the deposits, length of haul required, amount of crushing needed to produce one inch material, and the quality available in each deposit. It is sometimes deemed advisable to only screen the material, wasting the over-size, but as a general thing this is bad practice, as it wastes the best portion and also produces a material that binds less easily and ruts or corrugates more easily. However, it may be economical to follow this screening practice where the amount of material over 1 inch in size is quite small.

There is probably more gravel road produced by day labor forces than by contract. This is because there are and always have been many small jobs which the counties could do cheaper than they could contract. Since this has been going on for many years, the various counties have developed some quite efficient and well equipped organizations. Federal construction and many large county jobs are done by contract.

Some idea of the magnitude of the gravel road construction in Wisconsin can be gained by examining the following table covering the work done during the past three years:

Year	Miles Graded and Surfaced	Cost	Average Cost Per Mile	Surfaced Only Miles	Cost	Average Cost Per Mile
1921	973	\$ 4,020,000	\$4,130	504	\$ 719,000	\$1,430
1922	802	2,973,000	3,700	463	941,000	2,030
1923	1182	4,229,000	3,570	455	726,000	1,600
	<u>2957</u>	<u>\$11,222,000</u>	<u>\$3,800</u>	<u>1522</u>	<u>\$2,386,000</u>	<u>\$1,570</u>

This is a total of \$13,608,000 spent on gravel road construction on 4,479 miles

of highway; a very considerable program without any paving.

Naturally on such a large program, there are developed many schemes for carrying on the work. Equipment manufacturers have given much time and effort in the past few years to developing gravel equipment, such as loaders, crushers, screens and bins. The growing tendency is to make these outfits compact and easily moved. The less time lost in moving from pit to pit, the more money the contractor can make, for on sizeable jobs it is cheaper to move than make long hauls. Even where only one set-up is to be made, the ease with which the outfit can be installed, removed and transported is of great importance. The growing scarcity of labor has also forced changes in design, until now some of the modern plants are run with very few men and these generally of a quite intelligent class.

All modern plants pass the gravel over a screen or grizzly before any reaches the crusher. This causes only the particles needing crushing to reach the crusher, and therefore greatly increases the output. Such plants also return the rejections or over-size pieces to the

crusher. On jobs requiring considerable crushing it is economical to have

two crushers, a breaker and a reduction. This is especially true in coarse pits or quarries. A reduction of 4 to 1 is about all that should be attempted at one operation. That is, 8-inch stone can be reduced to about 2-inch stone on one operation and do it economically. The 2-inch stone should then be reduced to the required 1-inch size in a secondary or reduction crusher. The attempt to reduce coarse gravel to 1-inch material in one operation has been the cause of failure for many contractors, as it invariably reduces their output.

While a few years ago 100 cubic yards per day was considered a fair output, an average of 200 cubic yards is now expected; and it is not uncommon to have a plant turn out 400 or even 500 cubic yards in a day. This output is, of course, quite dependent upon the amount of crushing required.

The practice recommended by the national meeting recently held at New Orleans was that of having all material for gravel roads pass a 1-inch ring and building the road without the use of a roller. This has been common practice for several years in Wisconsin and neighboring states.

In Wisconsin the contractor is required to maintain a planer and a grader on the job and use them continually while surfacing is being laid. Travel is permitted, in fact, encouraged to use the road while surfacing is being placed to assist in compacting it. The contractor is required to proceed from the end



One of the modern double screening portable gravel plants now used extensively on Wisconsin's highways.

nearest the source of supply so that hauling will be done over gravel already placed. This is also advantageous to the builder, as sandy or wet subgrades interfere much less with his operations.

Some gravels are very slow to compact, in which case it is pushed by the grader into rows along the shoulder and gradually fed to the traffic as fast as it will compact. This feeding is done either by the contractor, or, if too long a time elapses, by the patrolman. Sometimes a whole year elapses before the gravel is all in place in the road surface.

A growing practice in most states is to place small stock piles at convenient points along the road for use as maintenance material.

During the past year the federal gravel work in Wisconsin averaged 1690 cubic yards per mile at a cost of \$2.22 a cubic yard in place. The average of all the gravel roads was considerably under this as some miles were resurfacing, and others had smaller quantities because of good soil conditions or lighter traffic.

Prices varied from as low as fifty cents a cubic yard to as high as \$3.25 in extreme cases. It can, therefore, be seen that averages mean but little. Every job is a problem by itself and the amount of crushing and the length and kind of haul will largely determine the cost.

In Wisconsin it is now considered economical to build gravel roads where traffic does not exceed four hundred vehicles per day. With bituminous treatments gravel roads have been successfully maintained with over one thousand vehicles per day.



A typical glacial gravel pit in Wisconsin. This one is thirty feet deep.

Blasting a Highway Through the Rock Bluffs of the Mississippi

One by one the "bad hills" on America's highways disappear. Dynamite and the steam shovel wear them down. Good roads are so vital to the prosperity of cities and farms alike that they must be built even though it means blasting through bluffs of solid rock, which was done in the building of the Maquoketa-Bellevue road, in Jackson County, Iowa, as described in the following article.

IN the early steamboat days of the Mississippi River, the town of Bellevue, Jackson County, Iowa, was content to lie down on the flats and face the river with the high rocky bluffs practically isolating it from the country to the west. As the hinterland developed, these bluffs formed a formidable barrier to trade. Going around them was out of the question, and going over them was extremely slow and difficult; so the people of Bellevue decided to cut a road straight through them.

The construction of this road, which is a part of Primary Road No. 62 from Maquoketa to Bellevue, has produced the most spectacular road work so far carried out on Iowa's primary road system. The cut through the solid bluffs, some forty feet in depth, is the heaviest rock cut in the state. There have been construction projects producing a larger amount of yardage of excavation, but none where the difficulties and the depths of the cuts have been so great.

The new road will wipe out an old

time trail that has been famous for its "bad hill." This old hill or grade was almost exactly one mile in length from the top of the bluffs to the valley below. For 2,250 feet, nearly one-half a mile, the easiest grade was 7 per cent. The heaviest grade on the new road will be 6 per cent. One long curve will take the place of the dangerous bends and the kinks of the old road.

Although lying in the extreme east corner in one of the roughest sections of any country in the state, where there is never any possibility of ever having all the road and bridge building funds needed to do all the work that should be done, the road Bellevue wanted and went after is now a reality.

Bellevue, in the early days, was a fuel landing point for steamboats. From that she grew into a logging trading point, and practically all of her early life she lived wholly wedded to the river and things of the river. Her main street, some twenty-five feet up from the low water level, lies along the river bank. Her business houses face the river and back on the bluffs; her homes nestle in the flat between the main business street and the bluffs that form a solid wall on the west.

But, when the day of the motor car arrived, enticing people to the open highway, the citizens of Bellevue found they must have better ways of getting up to and back upon the plain some three hundred feet above. It was then that the building of a road to the top of the hill with a 6 per cent grade was begun. To accomplish this it was found necessary to strike boldly into the solid rock bluffs and cut a way through. To wipe out the long climb of 5,300 feet, just a trifle more than a mile, the engineers estimated that it would require



Cutting a highway through the rock bluffs near Bellevue, Ia., showing the drill, steam shovel and tramway used in making the cut which at this point is forty feet deep.

The Highway Magazine

the excavation of 60,000 cubic yards of dirt and rock. This material has been hauled varying distances to fill in the long, low section and make an even 6 per cent grade from the top of the bluffs

Scenes on the Maquoketa-Bellevue road in Jackson County, Iowa, during the construction of that highway. Upper right, scene in the forty-foot rock cut near



Bellevue; Center, the fill made from the material taken from the big cut. Lower left, the wooden trestle ready for the tramway and dump cars used in making the fill.

to the main entrance of the town. Of the 60,000 cubic yards approximately 26,000 cubic yards were of solid stone. At the deepest point in the cut the depth is forty feet. Of the forty-foot cut, thirty feet are through solid rock and ten feet through the overburden of dirt. This road has been virtually blown out with dynamite. To bore the holes and plant the charges, contractor T. T. Jones used an ordinary tubular well drill exactly similar to the type used for drilling 6-inch wells.

There have been some extremely heavy charges fired to break up the rock so that it could be handled by the steam shovel. The largest shot was one in which there was exploded 6,015 pounds, a trifle over three tons, of explosives. In this charge there was a ton and a half of sixty and fifty per cent dynamite mixed, one-half ton of gelatine, and a ton of dumorite. Dumorite is an explosive of about the same strength as the forty per cent dynamite. In planting the huge charge a series of twenty-seven 6-inch holes, each approximately fifty-six feet in depth, was drilled. The explosives were packed in each individual hole. To explode the charge the cordite fuse system was used instead of the electrical method. By this system, instead of the entire series of charges being fired instantaneously, the trail of

the fuse is so laid and connected that the series of charges next the face of the bluff are fired an appreciable instant before the second series. Each series of charges fires a trifle later than the one in front, the theory being that the first charge would have an opportunity to loosen up the rock and start it on its way out and up, leaving the following charge to exert its full pressure on its own immediate section of rock.

The blast was a great success both as a display and as a demonstration of an economical means of breaking up solid rock so that it could be handled by the steam shovel. It tore loose approximately 8,000 cubic yards of material. The waste material was then hauled out of the cut on dump cars by a pair of gasoline locomotives. The trains were run over a wooden trestle work which has been built out over the flat below the main part of the hill.

Road No. 62 will in future years form an important link in the highway system between Rock Island, the great war arsenal and Uncle Sam's long range gun testing grounds, on the Illinois side of the river, just across from Bellevue.

Complete Arrangements

"Crimson Gulch hasn't parking space enough to accommodate the automobiles that come to town.

"No, sir," answered Cactus Joe. "This here is a growing community with expenses to meet. If we can't ketch a flivver for speedin' we get if fur standin' still."



Irrigation and Drainage

Draining Irrigated Land With Pumps in the San Joaquin Valley

By WALTER W. WEIR

Assistant Professor of Soil Technology, University of California

Because of the lack of adequate provision for drainage when first put under cultivation, many large areas of irrigated land have gradually lost their productivity because of water logging and alkali. In the Salt River Valley of Arizona and the San Joaquin Valley in California this condition is being remedied by the use of deep well pumps protected by portable pump houses.

As everyone knows, who is at all familiar with the subject of irrigation, wherever gravity water is plentiful and some places where it is not nearly so plentiful as the irrigator would like, there has been more or less water-logging and alkali injury.

In many instances this condition is very serious, as a matter of fact about one-third of the irrigated land in the west would be better if during certain times of the year, at least, it did not have so much water.

Drainage has always been and undoubtedly will for ages to come, be one of the problems of the irrigated sections. For various reasons, which are now quite well understood by the engineer, drainage in these sections has not met with the success that similar operations have enjoyed in the humid regions of the country.

The principal reason for this is undoubtedly due indirectly at least to the complications introduced by alkali. It has been found to be necessary to place drains at much greater depth than is required where alkali does not exist. Because the need for drainage is not usually apparent for some time after the land is first put into cultivation and because the condition comes on gradually,

resulting in slowly diminishing crop returns, a remedy is not applied until the returns from the land will not pay for the drainage.

The increased depth of drainage necessary coupled with the difficulty of removing the alkali, which has already accumulated on the surface, has made drainage very expensive. Because of the expense, comparatively little drainage has been done and often where attempted has been only partially successful because of improper installations brought about by false economy.

Within the past four or five years, there has been developed a new method of drainage which for certain localities promises to be very successful. This is pumping from deep wells. This method



An Armco ingot iron flume used in an irrigation project in the southwestern part of the United States.

was first demonstrated in a practical way in the Salt River Valley of Arizona in 1918, but has now become quite popular in other section, especially in the San Joaquin Valley of California.

Drainage by pumping can be accomplished when three or four fundamental requirements are met.

1. The surface water table must be a part of and directly connected with the normal ground water.

2. There must be some strata or layer of sand or gravel within a maximum of 200 or 300 feet from the surface from which it is possible to pump comparatively large quantities of water.

3. It is necessary to install and operate more or less continuously pumping plants of sufficient size to actually cause a general lowering of the water table. It makes no difference whether the excess water is removed from the bottom of the reservoir with a pump or from the top with tile drains. The effect will be the same, except from a practical standpoint, it can be lowered more effectively and economically from the bottom. Some of the larger installations have resulted in a material lowering of the water table at distances as far as a mile from a pumping plant.

The development of this type of drainage has resulted in the perfecting of a very compact, highly efficient, electrically driven, deep well turbine pump. When fully equipped these plants are

practically automatic and require very little attention.

A very interesting detail in the installation of such a pumping plant is the pump house now being supplied in California by the California Corrugated Culvert Company. This pump house, sold under the trade name Calco Portable Pump House, is made of "Armco" ingot iron and aside from having the quality of rust resistance, is light, portable and fireproof. The more recent pump installations do not provide a tower for pulling the pump when repairs are necessary. A Ford car equipped with an "A" frame backs up to the pump house, a half dozen nuts are unscrewed and the entire house lifted off the concrete foundation and set aside just as one would take the hood from an automobile when it is necessary to work around the engine. Under these conditions, the switch board is not attached to the walls of the pump house, but is supported by posts set in the foundation floor. When work on the pump has been completed, the house is picked up and set back in place and the Ford with its portable derrick moves on to another job.

The matter of being fireproof is an important feature of these houses, as recently a wooden pump house and tower burned, causing not only a complete loss of the house but considerable damage to the switch board and motor.



A portable Calco pump house in use in the San Joaquin Valley of California, which is described in the above article.

Wind River Diversion Dam Completed

The construction of this dam, at a cost of less than half a million dollars, will provide for the diversion of water from Wind River for the irrigation of more than 100,000 acres of otherwise arid land.

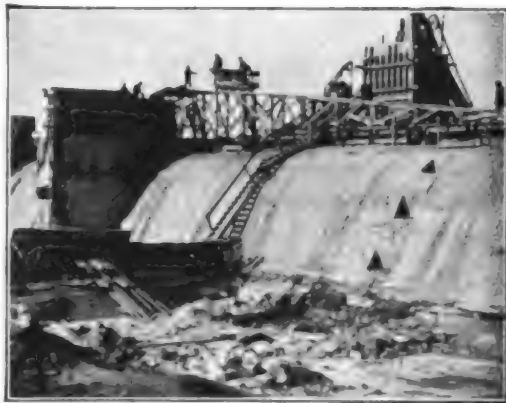
CONSTRUCTION of the Wind River diversion dam by Government forces marks the completion of the first large single structure on the Riverton project in Wyoming and permits the diversion of sufficient water from Wind River, a tributary of the Big Horn River, for the irrigation of over 100,000 acres of arid land in the Wind River Valley, in Fremont County, Wyo.

The diversion dam consists essentially of a concrete spillway 651 feet long across the main river channel, with a sluiceway, logway, and canal headworks at the north end, and an earth embankment 1,656 feet long connecting the south end of the spillway with the river bluff. The structure was designed for a maximum capacity of 40,000 second-feet, which corresponds to a head of 6.45 feet on the spillway crest and a 5-foot free-board for the embankment.

The masonry part of the dam rests on bedrock and has a maximum height of 35 feet. A fish ladder is provided at the south abutment. By agreement with the Wyoming Highway Commission, bridge piers were built as an integral part of the weir and the commission is to erect an 8-span steel highway bridge prior to December 31, 1924.

Both the headworks and sluiceway are equipped with radial gates, counter-weighted and raised by double drum hoists operated by a gasoline engine moving on track. There are six 10 by 10 foot gates in the headworks and four 10 by 12 foot gates in the sluiceway. The logway is provided with a wooden gate 10 feet wide.

Excavation for the entire concrete structure was carried to a suitable rock foundation, which proved to be shale and soft brown sandstone under the headworks and a tough bluish argillaceous sandstone under the spillway and sluiceway. The upper material consisted of sandy loam, cobblestones, gravel, and river sand varying in depth from 7 to 15



Constructing the Wind River Diversion Dam—
Wyoming's great irrigation project.

feet, except for a hole at the south end of the spillway where the depth to bed-rock was 27 feet. A gasoline drag line performed the bulk of the excavation, and the material was cast above and below the site to form dikes which served as cofferdams.

Most of the concrete aggregate was obtained from river gravel located at the site. The gravel was cast by drag line on a 3-inch grizzly and the oversize cobbles retained for use as plum rock. Material passing the grizzly was then delivered by drag line or slips to a portable screening plant of 25-cubic-yard capacity, having a 30-inch two-section screen with $\frac{1}{4}$ -inch and 1-inch perforations.

In concreting the lower portion of the headworks, sluiceway, logway, and a small portion of the weir, the mixer, which was power-operated and of $\frac{1}{2}$ -yard capacity, was installed at the silt basin above the sluiceway. Material from the screening plant was hauled by teams in $\frac{1}{2}$ -yard cars up an inclined trestle and emptied into stock bins just back of the mixer. Concrete was delivered in place through chutes wherever possible and elsewhere by $\frac{1}{2}$ -yard side-dump steel cars on narrow-gauge track or by wheelbarrows.



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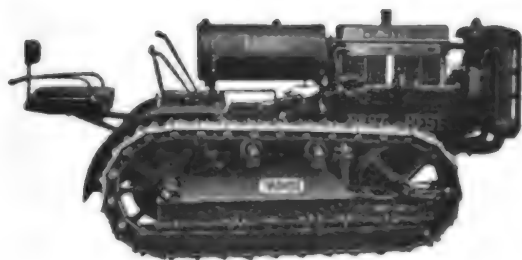
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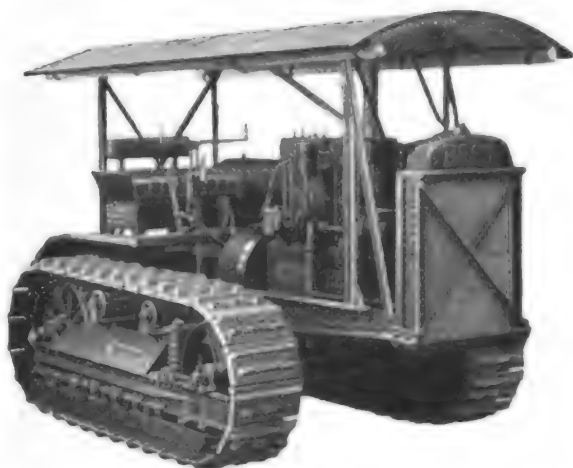
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The **HIGHWAY MAGAZINE**

**JULY
1924**

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Georgia, Atlanta
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Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

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The Kentucky Culvert Mfg. Co.

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The Maryland Culvert & Metal Co.

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The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XV

JULY, 1924

No. 6



Three Extremes in Transportation

Over the hot sands of California's desert areas the burro and the light wagon are still used; and in the snow covered forest regions of northern Canada dog teams and sleds have not yet lost their usefulness, as will no doubt be the wholehearted testimony of the aviator in the lower picture who has been forced to land his plane—the speediest modern vehicle of transportation—in order to replenish his gas supply.





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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Some Highway Fallacies

ONE of the factors retarding road development is lack of appreciation of the modern science of highway building and using.

We know too many things about roads which are not so!

Many of our highway ideas are 20 years behind the times. We haven't caught up with the engineer.

For instance, "all roads wear out. The enormous money invested in them is thus a capital loss."

Roads do not wear out. The surface of a good road wears, of course. So does the roof of a house. But replacing the house roof doesn't mean that the rest of the house isn't good. The surface of a road is its roof. If it wears out it must be replaced. But that doesn't mean that the right of way, the grade, foundation, and all of the material is any less valuable than at first.

"Trucks destroy roads. Therefore trucks should pay for roads!" That, too, is a fallacy. A truck no more destroys a road, when truck and road fit, than a baby carriage destroys a garden path. It is lack of maintenance which destroys roads, it is allowing too light a road to be built for the traffic it will bear, which destroys roads; it is failure to enact

wide tire and maximum load laws which destroys roads.

"There isn't money enough to pay for national highways. We will be bankrupt!" More fallacy. There are fifteen million motor cars in the United States. If they are worth on an average of \$500 each (which is an underestimate), they represent an investment of \$7,500,000,000. Did we get bankrupt buying them? We did not! Why should we get bankrupt buying seven and one-half billion dollars worth of roads . . . and the interest on seven and one-half billions would build today more national highways than we have as yet engineers and machinery to build.

Transportation has been, for us Americans, nothing but rail and water for all our history. Now we are compelled to translate the word into "highways" and "motors." Motors we understand . . . highways, as yet, we only partially comprehend, and "motor transport," as a whole, is yet a sealed book to most of us.

The first step in opening it is to get rid of fallacious thinking . . . to realize that what used to be, is no more true today, than what is proper road width and cost today, will fit conditions fifty, a hundred years hence! —Ex.

Examination Paper Gems

"A blizzard is the inside of a hen."

"A ruminating animal is one that chews its own cubs."

"The blood vessels are the veins, arteries and artilleries."

"The plural of spouse is spice."

"Tennyson wrote In Memorandum."

"Magna Carta said that the King had no right to bring soldiers into a lady's house and tell her to mind them."

"Louis XVI was gelatined during the French Revolution."

"Gender shows whether a man is mas-
cular, feminine or neuter."

"When England was placed under the
inderdict, the Pope stopped all births,
deaths and marriages for a year."

"Henry W. Longfellow was born in
Portland, Maine, while his parents were
traveling in Europe. He had many fast
friends; among the fastest were Phoebe
and Alice Cary."

Lifting Missouri Out of the Mud

By B. H. PIEPMEIER, Chief Engineer,
Missouri State Highway Department.

It costs two and one-half cents less per mile to travel over good modern highways than over unimproved roads, according to the chief engineer of the State Highway Department of Missouri. In the following article he presents some highly interesting facts on the road building activities of that state, where an effort is being made to increase the automobile license fee fifty per cent and place a tax of two cents per gallon on gasoline.

MISSOURI'S unenviable reputation among motorists as a mud road state is being rapidly dissipated by the activities of the State Highway Department.

In 1923 the Department completed 440 miles of hard surfaced roads and graded 595 miles of additional roads preparatory to surfacing; all at a cost of \$13,304,000. This is a gain over the 1922 production of 240 miles of hard surfaced roads and 177 miles of graded earth. It is planned to make the 1924 progress even greater than that for 1923.

Of the 7,640 mile state system there is now completed 1,506 miles of hard surfaced roads, or about 14 per cent of the entire mileage in the state system. In addition to this, there has been graded ready for surfacing 1,305 miles, or 20 per cent of the unfinished portion of the system.



Theodore Gary, Chairman, Missouri State Highway Department.

This work is spread throughout the 114 counties of the state in compliance with the Missouri Road Law. In addition to this heavy construction program, the Department was enabled by legislative act to inaugurate its maintenance work at the beginning of 1923.

The policy of the commission in regard to maintenance, has been that of providing the greatest possible aid to the present traffic by maintaining, in addition to the completed state roads, the main traveled highways that approximate the state system. In this way immediate service of a very substantial character is being given to the motorist, who, in turn becomes a booster for the state road program. In 1923, \$1,111,000 was spent in maintaining the 7,640 miles of main roads. Some reflection of this service may be seen in lowered per car



"Down to the hubs" in the mud was altogether too common an occurrence on the roads of Missouri before the Highway Department of that state began the systematic construction and maintenance of hard surfaced road, an excellent example of which is shown to the right—Route 52 in Buchanan County.

gasoline consumption, the average of which has dropped from 441 gallons in 1917, to 320 gallons in 1923. Doubtless, a number of causes have entered into this result, one of which is the increased mileage of hard surfaced roads, and another, the better condition of dirt roads due to our maintenance operations. The vehicle-mile cost of travel is at least two and one-half cents lower over good roads than over poor roads. This fact is becoming more fully recognized every day.

At this time Missouri has 476,700 registered motor vehicles. It is estimated that about half of these vehicles use in a large measure the state roads. The other half is confined to the large cities with their paved streets and boulevards. As the average car travels about 5,000 miles a year, a little figuring shows that the annual saving, when running over good roads, as compared with poor roads, is about \$125 per car. And since half of the motorists are assumed to use the state roads, our estimated annual saving is nearly \$30,000,000, or one-half of our present authorized bond issue. This large sum represents the yearly penalty that the present motorists are paying for poor roads. They would reap a benefit by paying larger motor vehicle license fees and a gasoline sales tax, thereby enabling the Highway Department to prosecute its work more rapidly. This annual saving of \$30,000,000 repre-



The Poplar Bluff-St. Louis Road in Butler County, Missouri, built by the State Highway Department in 1922.

sents, as it were, a dividend of about 19 per cent on the estimated cost of the entire system.

It is thus seen that the building of a state road system is a good business proposition and is justified on the grounds of economy alone.

An effort is now being made to secure a greater expenditure per year for road construction by issuing bonds in larger lots. To do this an increase in the basic revenue is needed to meet the obligations of the larger bond issues while keeping up the maintenance program. The Commission has recommended that the auto license fees be increased 50 per cent and that a sales tax of two cents per gallon be levied on gasoline. This would bring the annual basic revenue up to nearly \$10,000,000 per year and would enable the Commission, if authorized, to sell for construction purposes \$15,000,000 bonds annually during the next three years; to spend \$2,000,000 annually on maintenance; and to meet the current obligations, both interest and principal, on outstanding bond issues.

With such increases in revenue it would be possible to complete the state primary roads, which will carry the greatest part of the traffic, by 1928, and the secondary roads by 1940. In the meantime the \$30,000,000 annual loss will be diminished as the mileage of completed roads increases.



A 24-inch Armco culvert installed in 1912 near Moberly, Missouri, under a new road now paved with brick.

Measuring Road Wear and Tear

By HARLEY DUNBAR

Assistant Engineer, New York State Highway Bureau.

That drainage of the base is a more important factor than traffic in the life of a road surface is one of the significant facts brought out by the Vialog, a compact and remarkably accurate device now being used for measuring road surface irregularities. What has been accomplished with the aid of this recording mechanism by the New York State Highway Bureau is described in the following article.

FEELING the pulse of the highway is now a reality. Here in New York State we can tell you the truth about the condition of any road. We know whether our contractors are meeting the Department's exacting specifications. And after one or two surveys of any road we can prophesy with a fair degree of assurance just how that road is going to behave under topographical, climatic and traffic conditions.

This work is accomplished with the aid of the Vialog, a road irregularity recording device which can be conveniently attached under the instrument board of any automobile. As the inventor of this instrument, I do not feel entitled to go into a discussion of its merits, for the highway engineer, the contractor and the good roads advocate are primarily interested in what it does and what it proves. It has this advantage, however; being so compact and so comparatively simple in operation, it can be used twenty-four hours a day on as many testing cars as the highway department cares to press into service.

In New York's Highway Bureau we have three Vialog equipped cars, and since each can inspect 100 miles of paving within the hours of a short working day, it is seen that the state's highways can be covered in short order and at no more operating cost than would be re-

quired to drive a car over the prescribed course on a road inspection such as the automobile clubs conduct. The highway departments of California, North Carolina and New Jersey, as well as the city of Buffalo, will use this method of measuring road conditions.

What this system of road inspection will save taxpayers in roadbuilding and maintenance has already passed beyond the guessing stage. Every day the Vialog is telling us something new about road construction and maintenance, and every day it is proving anew certain facts which in escaping the attention of road builders have cost the public millions of dollars. One of these discoveries is of vital importance at this time.

Briefly, the Vialog charts (which record the surface

irregularities in inches per mile) are showing that we have been wrong in suspecting that traffic is the greatest enemy to the roads. We have had this clearly demonstrated by the fact that the first two years of a road's life are its hardest. A case in point is a 5.9 mile length of reinforced concrete pavement running westerly from the city of Albany. One section of this was built in 1922, the remainder in 1923. The 1923 Vialog test showed that whereas the best record for the newer sections showed but 23-inch irregularities per mile, the test for the road which had

"At the present moment we are particularly impressed by the fact that the Vialog is helping us measure road deterioration that is far more important than that which can be seen with the naked eye. It has shown us that the road with the improper base cannot give desired results no matter whether we double the thickness of the concrete slab or not. It has shown us why, and particularly where, all future roads must be built with full consideration of the subsoil, base and—most important of all—drainage. A pavement so designed will then give a good account of itself under the heaviest traffic."

Then They Sent For The Coroner

by Orin C. Crooker



Failure on the part of a motorist to obey the grade crossing sign resulted in the wreck shown above.

SEVERAL years ago, on a bright summer afternoon, a man was driving a touring car along the Dixie Highway. He was a business man of some prominence in his own community—well to do, alert and active, both mentally and physically. He came to a railroad crossing. It was not an obscured crossing. As he approached it the track could have been seen for a mile or more in either direction. However, without looking to right or left, this ordinarily alert business man and experienced driver piloted his car directly in the path of the Dixie Flyer which was rushing toward Chicago at the rate of sixty miles or more an hour. Less than 30 minutes afterwards a telephone call was sent to the county seat summoning the coroner.

This particular grade crossing accident marked an epoch in damage suits. Ordinarily, the parties injured, or—in the case of fatal accidents—their near relatives start suit against the railroad company. In this instance the railroad company sued the man's estate to recover damages for a wrecked train, an injured fireman and a dead engineer—crushed under his engine as it toppled over in the ditch. For the automobile had been caught under the pilot and skidded along the rail until it caught in a switch, derailed the powerful locomotive and set two or three cars criss-cross on the track. Only a few weeks ago the writer noticed a press item to

the effect that the highest court had sustained judgment entered against the estate of the man who had caused the wreck.

With this instance to serve as a starting point, let us consider some phases of the responsibility of the motorist who uses the public highways. At almost every grade crossing in Illinois, and in many other states as well, there is a little round sign bearing the one word "Stop" upon its face. Perhaps some persons have imagined that the railroad company placed it there out of courtesy only—a gentle reminder that it would be best for the motorist to slow down to 20 miles an hour or less before taking a chance with death at the crossing just ahead. Not so! The railroad company placed that sign there with a well defined motive—to remind the motorist and others that upon them rests a responsibility to come to a complete stop. For back of that little sign is a big law which says that one must stop (not merely slow down) before crossing a railroad right-of-way. Of course, no one expects the law to be obeyed in all cases. But here is the point: If one fails to stop and should meet with an accident, he comes into court as an offender against the law and as one who has not heeded his own responsibility. If he does stop, the chance is very small that he will meet with trouble.

It might seem needless, almost, to place such a sign at a railroad crossing

where even the space between the rails is grass grown. Yet the upturned auto, shown in one illustration with its wheels pointing skyward, was wrecked at a "grass grown" crossing by a freight train moving not over ten miles an hour. Although it was not necessary to send for the coroner in this particular instance, four dangerously injured persons were rushed to the nearest hospital. This photograph is an eloquent testimony of the fact that he who loses sight of his responsibility when traveling the highways of our country, is apt, sooner or later, to come to grief. When a railroad admonishes one to "stop," "look," or "listen," the warning is given with the most kindly spirit.

There are other highway signs that are also intended for the salvation of the highway traveler. "Dangerous Curve Ahead." "Go Slow"—it is spelled "Slo" in Indiana. The skull and cross bone sign, found in some localities, is gruesome enough, but less so than some of the accidents it seeks to prevent. Back of all such signs on a public highway there is the good will of some organization or the good intention of some well-planned law. And the idea, in either case, is simply to remind those who pass of their responsibility toward themselves and others.

The modern highway is subject to mortifying perils which are peculiarly its own. Particularly is this so when the pavement is crowded and every driver is seeking a chance to pass the car just ahead. Hundreds of "three-cornered



The automobile was ground to a tangled mass of junk beneath the wheels of the derailed train in this crossing accident.

wrecks" have occurred because the drivers, who tried to advance their positions in the procession, failed to judge the speed of a car coming from the opposite direction. The ordinary effect of such mis-calculation is a head-on collision between two of the cars, one of which invariably is thrown back upon some other passing car.

According to figures announced by the National Safety Council, approximately 15,000 people were killed in the United States in automobile accidents during 1923. On the frequently used basis of five to one, this means that there were also about 75,000 people seriously injured in motor vehicle accidents during the same period. And a large proportion of these accidents is due to the fact that some one failed to measure up to the responsibilities which traffic on our modern highways impose on all who use them.

•••••

Short Turns

Traffic is not so heavy on the Straight and Narrow Way that they have to have any Stop-Go signals.

We read about a car with a conscience, but what we want is a tire with a conscience—one that won't go down till we get out and tell it to.

Some folks take the Biblical expression, "Behold, I stand and knock," too literally.

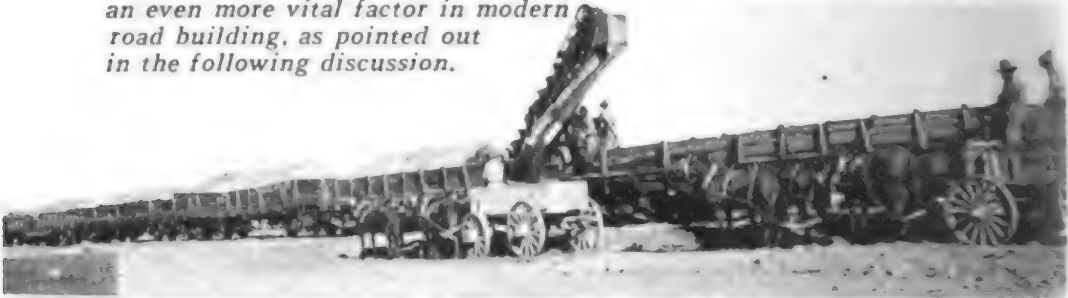


This wreck occurred at a "grass grown" railroad crossing, the automobile being hit by a slow freight train, one not going over ten miles an hour.

Preparing the Subgrade for a Gravel Road

By LELAND F. JAMES,
Former Instructor Experimental Engineering and Mechanical Processes
at the U. S. Naval Academy.

Highly important though the selection, construction, and maintenance of road surfaces may be, the preparation of the subgrade is an even more vital factor in modern road building, as pointed out in the following discussion.

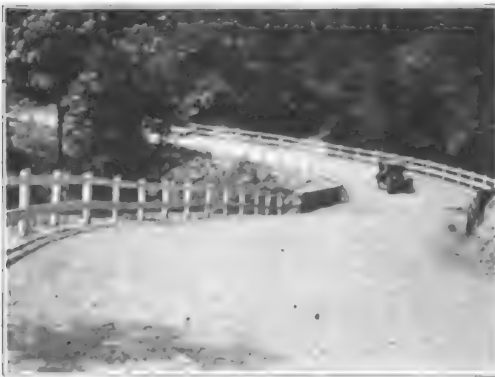


Where gravel must be brought from great distances, modern equipment is necessary in the interest of economy.

THE object sought in preparing the subgrade for a gravel road and, in fact, for all classes of roads, is to secure a solid road bed that will sustain all loads without displacement. This depends primarily upon the bearing power of the soil along the proposed route. The United States Bureau of Public Roads has made exhaustive tests with a view to determining every possible means of increasing the bearing power of different kinds of soil under varying conditions, and there is already available much valuable information along this line. It is not within the scope of this article to enter into a discussion of drainage, which will be treated separately, except to emphasize again the importance of keeping the sub-

grade clear of water. Drainage is, of course, the very first consideration; and it must satisfy all of at least three conditions—it must be adequate, effective and permanent.

If the road is to be built along a new route, or if part of the old road is to be relocated, the first step is to clear the right of way. This consists in cutting away trees and undergrowth, blasting or pulling stumps, and grubbing out roots and other perishable obstructions to a depth of at least eighteen inches below the surface. The roadway is then loosened to such width and depth that it can be brought to the designed line and grade through cuts. Average work of this kind can generally be handled with teams and ordinary road plows, but if there is much tough ground breaking to be done a rooter plow is better adapted, in which case a tractor should furnish the power required, provided other conditions admit of its use. The loosened soil is moved to the nearest fill or otherwise disposed of clear of the right of way. Where there are long stretches of shallow cuts, or where the topography is such that the material has to be borrowed from the roadside for filling in on long hauls, an elevating grader may be profitably employed, the borrowed material being dumped into wagons or trucks for further transportation to the site of the fill.



View on the Connecticut River Road in Windham County, Vermont. An excellent example of a gravel highway.

On short hauls, wheel or drag scrapers

find a ready use as efficient earth movers, one regular team for hauling and an additional team to assist in loading. If space for turning is for any reason limited, simple appliances—plows, wheelers, light dump wagons or carts, picks, shovels, and the like—should be at hand.

Through large cuts, it is often advisable to use a power (steam, gas or electric) shovel to load the transporting equipment. Where the fills are extensive and material has to be borrowed from a pit removed from the right of way, a large power shovel is almost indispensable, and more elaborate arrangements for earth moving have to be made to keep up with the loading rate of such a shovel. A case in point is that of moving 800,000 cubic yards from a 48-acre borrow pit to build alternating stretches of embankment covering a total length of nearly three miles through a flooded swamp—Santee River, South Carolina, Federal aid project No. 85. Three regular trains of seven 12-yard to 16-yard dump cars each were loaded with a 2½-yard steam shovel, and run over steel tracks supported along the line of the fill by a temporary pile-driven trestle built out of swamp timbers.

A disc harrow is a valuable piece of grading equipment for breaking up clods or for loosening sod ground in advance of the standard road grader, which is usually relied upon to blade the subgrade to its final shaping.

After all, the problem of grading and



A 72-inch Armco corrugated culvert installed under the Prescott-Jerome Road in Arizona. It is but one of the many installations of Armco culverts under this picturesque highway.

earth moving is one of balancing the advantages to be derived from the use of any particular combination of equipment against the cost of the work for which the equipment is employed. As a general rule, however, it may be stated that on the larger contracts machine power is in high favor because with up-to-date equipment, work is expedited and fewer men are required; while on the smaller jobs team power units are of advantage in that the teams can be



In the above picture is shown the subgrade and the method used in spreading the gravel on Russell Road, Alexandria County, Virginia.



An Armco ingot iron culvert draining a side hill road with a liberal extension to prevent washing away of the embankment.

readily shifted around for the several operations of hauling, plowing, etc.

It is easily understood that earth embankments have a tendency to shrink, which makes it all the more imperative that foreign matter of a perishable nature be excluded from their make-up; and in other respects great care must be exercised in their construction. Material dumped on them should be evenly spread in as thin layers as practicable and well compacted, either by running over them with a heavy roller or else by allowing ample time for settling before adding the finished road body. If a fill is opened to traffic before it is thoroughly settled to its final resting shape, constant attention must be given to keeping it bladed to a uniform smooth surface. In filling along a hillside where the tendency is to slide, it is a wise precau-

tion to roughen the original surface in direction of the length of the embankment. This can best be done by plowing or excavating about two feet apart along the length, which, as a rule, will obviate the necessity of putting in expensive retaining walls to hold the fill material in place. Further tendency to slide may be prevented by placing a culvert at the cross-road to provide against the undermining influence of hillside water flow. Since such a culvert is to remain as a part of the permanent road, it should be of durable material, easily and quickly placed without hindering other work in progress, strong enough to safely sustain all loads, and sufficiently flexible to adjust itself to settlement without damage. An Armco corrugated culvert will admirably fulfill these requirements when properly placed underneath the roadway. The discharge end of the culvert should extend far enough over the side to clear the base of the fill, and riprap or other substantial protection should be added at the point where the culvert passes through the hips of the fill.

Rough cut logs or field stones placed along the hips is an excellent preventative against side washing during the initial stages of settlement. Through low lands where adequate drainage is impracticable, the tendency to undermine may be lessened by adding some non-slaking substance to the subgrade surface, with the idea of securing as nearly as possible a cemented coating impervious to the action of the water.



This new gravel road, which has just been opened to traffic, is a little slow in packing, a favorable quality rather than a weakness.

What Forty Years of Highway Improvement Have Meant to a Tennessee County

By ROBERT SPARKS WALKER

The author's father, W. T. Walker, now 76 years old, has supervised the construction of more good roads than probably any other man living in the South today. He has contributed in a large measure to the progressive and constructive developments which are so interestingly described by his son. The article shows how inextricably interwoven economic and educational advancement has been with the building of the highway.

AS varied as the species of some wild animals and plants, are the roads of certain localities. The evolution of the country road presents one of the most interesting ascents in civilization found in human progress. As it was absolutely necessary for plant life to precede animal life, so must good roads ever precede better homes, better schools, better churches and better everything.

You may take any progressive section of the United States and write its brief history, and its story will be parallel to the story of any other progressive country, for every step upwards found a foothold in a few feet of good substantial solid road.

With Chattanooga, Tenn., and Hamilton County in which it is located, the writer has been familiar for more than forty years, and during that time has seen it grow from a wilderness to one of the most progressive and modern

communities found anywhere in the United States.

Back in the early eighties, the passing of the ungraded dirt roads, the low-



A picturesque spot on a Hamilton County, Tennessee road that has been surfaced with creek gravel, but evidently never rolled.



An unimproved country road that has been made passable through the use of thick layers of straw spread over the low, muddy sections.



A stretch of the old abandoned roadbed of the Southern Railway in Hamilton County, Tennessee, now used as a highway

est type of thoroughfare, began with the building of corduroy roads.

At the time of their construction, the county seat was not much more than a rural village; the country school houses were rude, planked-up affairs of rough lumber in which school sessions lasted from three to five months. Communities and schools that had as many as five miles of territory intervening, were almost completely isolated from each other through lack of passable roads. As a consequence, men and women reached maturity within a very limited radius and knew little or nothing of adjoining neighborhoods and their people.

When the roads were not graded, the schoolhouses, the dwelling houses and churches went unpainted.

The next step upwards was graded roads that radiated from the county seat. But still there were no connecting roads which were passable. Along with the graded and graveled pikes, came a little better grade of schoolhouses, homes and churches; and the practice of painting rural buildings also followed in the wake of the graded roads. But still, the communities were isolated, for the graded highways benefited chiefly the county seat and the citizens located on the way. These early thoroughfares that superseded the corduroy roads, showed a marvelous advancement over their predecessors, and were coated with a layer of

good creek or ridge gravel. But road rollers were then unknown, hence the compacting of the surface depended on the narrow tired vehicles plying between the city and the country.

There were no serious complaints to be made of the kind of surfacing material used, for it is a delight even today to drive an automobile or any other kind of vehicle over a well-graded country road which has had a good layer of creek gravel spread and rolled over its surface.

In this particular community there is one unusual piece of public highway. It was formerly the bed of the Southern Railway's line between Ooltewah and Chattanooga, over which heavy trains were drawn for more than fifty years. When the writer made a trip over the road in an automobile in early spring during a rainy season, it was marvelous to observe the amount of water pouring down this roadbed from wet weather springs, and note that weeks of washing carried practically none of the surface away, as illustrated in the accompanying photograph.

Then came the introduction of the



A dirt road in the mountains of Tennessee built years ago when timber was cheap and rail fences were a common sight.

ock crusher to prepare the material for surfacing the macadamized roads. For years this community directed the construction of its country roads along macadamized lines, but the subsequent breaking up of the surface into holes through months of hard wear led the authorities to seek better material and better methods of road making. In the



Above is shown a section of chert road whose whiteness almost blinded the motorist on hot sunny days, while the pulverized chert left a white coating on everything alongside the road.

meantime, rural residences, schools and churches kept up their house painting and other improvements, mostly on the inside of the buildings. For example, the school houses got rid of many awkward seats and benches, and installed more modern ones.

Shortly after this modern road machinery came into use. The roads that radiated from the county seat were repaired and re-surfaced with chert. Road rollers pressed the white chalky looking material so hard that it made a good surface, one that shed water well in wet weather, but that almost blinded the eyes of the traveler on hot, sunny days. Wagon wheels in time ground the surface material into powdery masses, and frisky winds lifted the loose material from the road and left it spread out over the foliage of trees and plants for many rods about. Rains helped steal the loose surface, and pretty soon the chert surface was a mass of "goose bumps," so rough and sharp that it made tires tear and travelers swear!

During the reign of King Chert, connecting roads were constructed, and rural people began to become acquainted

with their neighbors. Rural clubs and other organizations of a business nature were formed. The people began to think of better schools, of better homes and better churches.

Treating the chert roads with oil or tar was the next step. And then, finally, came the construction of the modern concrete highway in the community whose history I am briefly pointing out. With it, as if by magic, new school buildings made of brick and equipped with the most modern furniture and heating apparatus, sprang up. New churches also replaced the decrepit old edifices. Modern homes came to take the place of the old type buildings, closely related to the pioneer's cabin.



The center and lower scenes show the more modern equipment now used in the construction and maintenance of roads in Hamilton County, Tennessee.



Modern thought followed in the wake of the modern thoroughfare so naturally that few people have taken any more notice of it than the healthy normal person takes note of the beating of his heart.

Good roads made rural free delivery of mail possible, and they also brought the farm demonstrators, many of whom introduced modern machinery and conveniences that have increased the farmer's earnings and provided him with comforts he never knew before.

It is universally conceded that agriculture stands as the basis of human happiness and prosperity, but good roads make a block in the foundation that lies so close to the bottom that it is sometimes difficult to determine whether it or agriculture rests on the ground floor,



Draining a New Residential Subdivision

How one thousand beautiful home sites were developed in a tract of low land on the outskirts of a city through proper drainage.

RESIDENTIAL subdivisions by the hundreds have been developed during the past few years. Remarkable progress in road building and automobile manufacturing has put within the reach of thousands who earn their livelihood in the city homes of their own on the outskirts. Figuratively speaking, it has brought these outlying areas closer to downtown. And much as modern drainage has contributed to the construction of roads leading to these suburban residential sections, it has contributed just as much to the value and success of the subdivisions themselves, for many large sections in which are located beautiful homes, gardens, schools, churches, etc., were once extensive areas of swamp or land too low and wet to be of any practical value until adequately drained.

Some of these subdivisions are located too far from the main part of the city to make the extension of the city sewer system feasible or practical, at least during the first few years. Though later, as such sections fill up, this is the natural

course of events. Undrained, these lands are practically worthless, and often an actual check to the growth, development and health of the city, but drained they become highly valuable tracts and encourage expansion.

An interesting example of developing a residential subdivision is that just recently completed near Glendale, California. Here Bellehurst Park, a tract of 214 acres, has been converted into a high class residence section, with a thousand home sites. It was laid out by Edward Lynch, civil engineer of Los Angeles, who directed all the engineering work.

To make this attractive section available for high class residence purposes, it had to be drained. To do this, the contractors, Bates & Borland, installed 30-inch Armco corrugated culverts, 170 feet long. And to prevent any back flow during high water from the Verdugo Wash, into which the culverts empty, Calco automatic drainage gates were attached to them.



Calco automatic drainage gates attached to 30-inch Armco corrugated culverts used to drain Bellehurst Park, a high grade residential subdivision near Glendale, California.

Millions of Acres to be Reclaimed by Colorado River Irrigation Project

How to control the Colorado River so as to prevent floods; provide water for irrigating the greatest possible number of acres of now arid and semi-arid land in the seven states of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming, and at the same time provide for the development of the maximum of water power, is the task facing the engineers and others connected with the Colorado River Project.

ON the deserts of the Southwest lie bleaching in the sun the bones of men and animals. Heat and thirst brought them down. But great stretches of territory that once were deserts and took the lives of hardy pioneers, have been conquered and reclaimed by the courage and enterprise of the engineer. They are now supporting life where they once destroyed it. And where now are many thousands of acres in Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming that challenge in many places even man's attempt to explore will some day be fields of grain, woods, orchards and flower gardens.

The Colorado River drains 244,000 square miles of territory, 156,160,000 acres, or as much as England, Ireland, Scotland, Wales and Italy put together. Large portions of this territory have very little rainfall, only from two to eight inches annually. Irrigation must be depended on, and already in the states of Arizona, California, Colorado, New Mexico, Nevada, Utah and Wyoming 11,714,447 acres are watered in this manner, but that is only a small portion of the land in this region of the United States that can be made productive through irrigation.

Water for irrigating this vast stretch of territory may be obtained from the Colorado River and its branches. But taking water from this river, whose flow varies from about 175,000 to 2,500 cubic feet per second involves the rights of a number of states, and it also involves some gigantic engineering feats in storing and controlling the waters of this river which begins to overflow its banks when the flow reaches 50,000 cubic feet



The only messages from the outside the survey expedition received while in the canyons and gorges of the Colorado River came via radio.

per second. The three great phases to be considered in a project of this kind, which is quite as momentous an undertaking as the building of the Panama Canal, are flood prevention, irrigation and power development.

The need for accomplishing this three-fold purpose was recognized when the League of the Southwest was formed in 1917 by the governors of the seven states of Arizona, California, Colorado, New Mexico, Nevada, Utah and Wyoming. The meetings of this League developed very little, however; so in 1920 a commission was formed through appointments by the governors of these states. The new commission drafted a bill to be acted upon by the various states which was done. Shortly after this the governors again met and drafted a bill to be submitted to Congress, authorizing the seven states to enter into a compact for the distribution of the

water of the Colorado River with the approval of the Federal Government. This bill, with slight modifications by Senator Mondell of Wyoming, was passed and is known as the Mondell Bill. The legislatures of the seven states authorized their governors to appoint members of an organization to be known as the Colorado River Commission, which was to have authority to adopt a plan for the distribution of water subject to ratification by the legislatures of the states. When in 1922 Herbert Hoover was appointed chairman of this commission by President Harding, the Commission after several meetings in the various states formulated the Colorado River Compact.

It is not at all surprising that there should be some difference of opinion as to the amount of land within each of these states that could be irrigated at a price per acre that would make it a practical investment. The difficulty in making an accurate map of this territory with its deserts, mountains, deep canyons

gorges of the Colorado River, which was started in 1909. Complete records are now available of more than 1200 miles of the Colorado and Green Rivers and their principal tributaries.

Many times the little band was in danger of being wiped out as they moved down the river in their small boats through gorges whose precipitous sides of solid rock rose at times thou-



In Colorado's Canyons

The upper right hand group is the expedition of the U. S. Geological Survey led by Colonel C. H. Birdseye which charted the canyons of the Colorado river. The scenes in the center and lower pictures were taken in the canyons where the party braved many dangers, and for a number of weeks were given up for lost, as they had no means of informing the outside world of their whereabouts.



and gorges, is great enough to try the courage, skill and endurance of the most courageous and resourceful engineer.

It was only in the late fall of 1923 that an expedition of the United States Geological Survey, led by Colonel C. H. Birdseye, Chief Topographic Engineer of that department, completed the work of mapping the waters and canyon

ands of feet above them.

The chief purpose of this expedition was the location of power sites, of which there are a great many on the Colorado River and its branches. It is estimated that twelve million horsepower can be developed along this river and its branches in the seven states of the basin.

Deciding on where to build the dams so as best to serve the three-fold purpose of flood control, irrigation and power and allotting water in proportion satisfactory must be decided on before the development of this project can go ahead, but regardless of where the dams will be built and the amounts of water allotted to the various states, it will be one of the greatest engineering feats ever attempted by man.

Reclaiming Arid Land in Taos County, New Mexico

Thousands of acres of now waste land will be made productive, and cities and low lands will be protected from floods, and much power will be developed through the irrigation and reclamation project now under way in north central New Mexico.

THE recent formation of the Carson Reclamation District for reclaiming 77,000 acres of land west of the Taos Canyon on the Rio Grande River, including the stations of No Agua, Tres Piedras, Servilleta, Taos Junction, and Barranca on the D. & R. G. W. R. R. in western Taos County, New Mexico, assures the early undertaking of a great project which will greatly enrich this part of the state, furnish flood protection for large areas now constantly threatened, and provide power for the development of an extensive territory rich in natural resources.

A plan for the reclamation of the lands of the Carson District consists of reservoirs to control the flow in the Rio de los Pinos, San Antonio, Brazos, Tusas and Vallecitos streams; canals to divert these unappropriated waters, amounting to about 140,000 acre feet, and lateral canals and ditches to carry these waters out over the surrounding lands. It is also proposed to construct a diversion dam on the Rio Grande, near the mouth of Latir Creek, about 20 miles south of the Colorado-New Mexico state boundary line, and to divert the waters flowing in the Rio Grande at about 7,400 feet elevation out over the rolling mesa, crossing the Carson Arroyo and passing near Servilleta and Taos Junction, continuing thence southwesterly on the top of the high table lands of the Black Mesa and dropping down to about 5,650 feet elevation near the mouth of the Chama River, making a total drop of about 1,700 feet in addition to the grade allowed for about 60 miles of main canal to accomplish these purposes.

The average flow of the Rio Grande at this point is in excess of 808,000 acre feet of water per annum which, after allowing for losses, would give a mean average flow of over 1,000 second feet. This would develop in excess of 155,000 horse power. If this project is added there will



An Armco ingot iron flume which has carried water for years on an irrigation project in California and is still in excellent condition.

be much additional land brought into the District, which could be reclaimed by surplus waters and made to assist in carrying the added cost of between \$6,000,000.00 to \$10,000,000.00. This power could be used in the nearby region in electrifying railroads, pumping for irrigation, manufacturing, mining, domestic use, etc. One irrigation, in addition to the natural precipitations, is all that is required for land in the upper district; two in the middle areas and three or more on the lower elevations.

The cost of this District will be met through the issue of bonds over a period of 20 years, at 6 per cent interest per annum. When the hydro-electric power project is adopted by the District, additional cost will be placed upon the District, but there will be an income of from \$50 to \$100 per year per horse power.

Some of the land affected is level and the rest is rolling mesa and open valleys. In reality they form the southern extension of the great San Luis Valley of Colorado. This area is bounded on the east, south and southwest by the deep canyons of the Rio Grande, Rio Chama and the Rio Vallecitos, so that there will be no "drainage problems" as it is naturally well drained.



Iron Umbrellas to shelter half a million people

ARMCO
INGOT IRON
Resists Rust



EVERY day 540,000 people travel on the Chicago Elevated Lines. More than 5,000 trains are run every twenty-four hours.

With this enormous responsibility the Chicago Elevated Railways Company can take no chances with equipment or materials that do not pass the severest service tests. Every precaution is taken for both the safety and the comfort of the passengers. Whenever better materials are discovered, the Company replaces the old with the new.

It is in keeping with this policy that the 207 stations on the line are being re-roofed with Armco Ingot Iron. Day and night—in every kind of weather—the passengers will be sheltered under Ingot Iron "umbrellas."

Tested for five years

Samples of many different iron and steel roofings were tested before Ingot Iron was chosen for this job. For five years the metals were subjected to the severest laboratory and service tests. The metal which best resisted

rust and corrosion under these severe conditions was Ingot Iron.

In industry and in the home

The purity of Ingot Iron makes it the ideal base metal for zinc coating. Because of its density and uniformity, Ingot Iron takes and holds a coating of zinc much better than does ordinary sheet metal.

Because of its many years of service life, its great ductility, and its unusual affinity for zinc, Ingot Iron is constantly specified for roofing, siding, window frames, ventilators, skylights, rain gutters, down spouts, tanks, culverts, and other building purposes where durability counts.

Look for the Armco Label

You can identify articles manufactured of Armco Ingot Iron by the blue and gold Armco label. This label is your guarantee of excellence.

Armco Ingot Iron in sheet form can be identified by the blue Armco triangle, stamped on every sheet before it leaves the mills. It will pay you always to look for the Armco trade mark.

THE AMERICAN ROLLING MILL CO., Middletown, Ohio

MOVING MOUNTAINS THROUGH A PIPE

In 1913 the great Ohio flood did vast damage, cost many lives, and threatened the city of Dayton and the entire valley with destruction. Engineers were confronted with the task of controlling five rivers; and to do this they determined, literally, to swing the hills across the valleys through dredge pipes.

No dredge pipe then in use could withstand

the terrific wear and tear of the biggest dredging operation in the world. The American Rolling Mill Company, Specialists in Steel and Iron, were called upon. They finally produced special analysis steel dredge pipes that did the job. Seven million cubic yards of material were pumped through these pipes. Then the pipes were sold at second hand! Need more be said?



"Economical"

Send for a copy of the new Best Tractor Catalog.

It contains details of construction showing why Best Tractors can perform so well.

"Our Best 'Sixty' has revolutionized our cost of road construction and maintenance," writes the engineer of a Colorado County where the Best has been used for pulling scrapers, elevating grader, scarifier and snow plows. "In fact, it has never failed in anything we have asked it to do and has been very economical both as to repairs and operation."

Investigation of the work of Best "Sixties" and "Thirties" on any job will prove worth your while. A list of owners will be sent on request.

C. L. BEST TRACTOR CO.

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BEST TRACTORS



Men Who Inspect Culverts Say—

"Our county has used ARMCO Culverts for many long years. I have made careful search for pipe that has proved deficient, but I'm compelled to state now that there is no ARMCO Pipe but what is in the best of condition today. All of them are doing their work."

(By a County Highway Superintendent—Name on request)



It has been more than 16 years since the first ARMCO Culverts were installed under American highways and railways.

This period is too short to pass final judgment on any type of culvert, but men who have kept installation records—men who have kept account of culverts of all types—who know the present condition of the culverts they have installed—THESE MEN STATE THAT ARMCO CULVERTS ARE THE MOST DEPENDABLE TYPE IN GENERAL USE.

There is a manufacturer in almost every state and in Canada, making Culverts, Flumes, Siphons, Tanks, Roofing, etc., of genuine, rust-resisting Armco Ingot Iron. Write for full information and nearest shipping point on products in which you are interested.

Look Under Your Roads

ARMCO CULVERTS

The HIGHWAY MAGAZINE



August
1924

**Write to the nearest manufactures for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Idaho, Pocatello
The Burnham Mfg. Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equip. Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The Burnham Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Regina, Calgary, Vancouver, Vernon

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Laying Concrete on Steep Grades

The accompanying illustrations show an easy method of laying concrete quickly on steep grades, used in San Francisco. The concrete was mixed in one location at the top of the hill and carried by movable chutes to the bottom. The chutes were made in sections and were removed as the work progressed toward the top of the grade. The use of gravity instead of trucks in transporting the concrete resulted in a substantial saving to the contractors.





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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Something for Nothing—?

MOST financial difficulties and a peck of other troubles are caused by trying to beat the game—get something for nothing—find a long bargain * * *

There is the salesman who offers the merchant "long terms" on his goods. Looks good to the merchant, too—but you know the goods can't be quite up to standard or the salesman's house could never carry the long term accounts.

There is the insurance man who comes to you with the wonderful policy—low premiums—big benefits. It looks reasonable, especially when he explains how much money his company makes on investments. But, you can take a pencil and paper and prove it can't be done.

There are also fire sale clothes, bankrupt sale jewelry, "demonstrator" automobiles. It's strange that so many people should be taken in by these threadbare games, when everyone really knows that he isn't going to get something for nothing. Offer to sell a man a five dollar bill for \$2.50 and he'll hesitate—and in most cases end by turning down the offer. It's been tried.

But, let the glib stock salesman come

in with some "ground floor preferred" in a Western copper mine, let him give his "customer friend" a good dinner, or a trip to the big town, and offer to throw in a few shares of "common stock" or a few cases of "bootleg," and money begins to change hands.

You can't beat the game. It all goes down on the expense account—and the man who buys pays.

Every article you buy has a fair price. Cord tires are not lower priced than fabric tires. The men who sell an article at a fair price don't camouflage. They are not going to sell it to you for less than its right value. The right man plays no favorites. He does not "gyp." They are not going to "throw in" a pair of suspenders, an extra set of tires or a loud speaker for your radio unless you pay for them and pay well.

Nine times out of ten, this so-called "friendly selling" is simply a means of putting over a second-rate product. Give a salesman a good product and he doesn't need to have a couple of bootleggers and a cafe owner on his payroll.

An honest product, honestly sold, is the foundation of success in the world of business—has been and always will be.



The famous Storm King Highway in New York.

Arkansas' New Highway Program

By PAUL GRABIEL
Editor, "Arkansas Highways."

After one of the greatest battles for good roads ever held in any state, Arkansas has adopted a highway program which is rapidly bringing that state to the front in modern highway building. One of the leaders in the struggle herewith describes some of the features of the new policy.

ARKANSAS, the Cinderella of the Sisterhood of States, has come into her own in the matter of modern highways in almost as sudden and dramatic a fashion as the original Cinderella was lifted from her despised and lowly estate to become the honored mistress of a princely domain.

One year ago without a State highway law of any kind, her highway department paralyzed by a vetoed biennial appropriation and a withdrawal of Federal Aid, and her public sentiment demoralized by a determined and persistent anti-road propaganda by radicals and repudiationists; she finds herself today with the most efficient highway organization in her history. Her new state-wide law, which is being studied and copied in many of the older states, is rapidly bridging all the gaps in a Federal Aid system of 6,700 miles that when completed will represent a permanent investment by the state of approximately \$70,000,000.

The story of this sudden and happy reversal of form is indeed a romantic one tinged through and through with the colorful personality of the present state highway commissioner, Herbert R. Wilson, known far and wide as the "stormy petrel" of Arkansas politics. Mr. Wilson, who bears the distinction of being the only "no-legged" highway commissioner in the United States, both limbs having been lost at the age of 11 through what the doctors then called



Herbert R. Wilson, Chairman
Arkansas State Highway
Commission

"inflammatory rheumatism," is the real "father" of the new program.

His vision, great tenacity of purpose and rare knowledge of political strategy, carried him and his department through one of the most serious "storms" that ever threatened a progressive road program in America and brought Arkansas in one stroke from the position of a laggard, and an apparently confirmed and hopeless one, to that of a leader in the development of the ideal Federal Aid system.

At the special legislative session of September-October, last year, Mr. Wilson's forces drove through the state's new highway law, known as the Harrelson Act. Under this law Federal Aid was restored, and permanent state maintenance provided for and financed through a four-cent gasoline tax. The construction of several hundred miles of missing links in the state system was



A beautiful stretch of road known as the "Big Creek fill" on the Helena-Marvel Highway, in Phillips County, Arkansas.

then immediately resumed. The question of repudiation of district road bonds, the real objective of the anti-roads forces, was forever settled; and out of the chaotic thought that had been encouraged by these forces was crystallized a healthy sentiment that will effectively prevent any serious recurrence of the trouble.

As a preliminary to the inauguration of the new policy of the State Highway Department under the Harrelson Highway Act, tours of inspection of the roads of the state were arranged by Commissioner Herbert R. Wilson. A series of educational meetings was held in connection with the tour, at which the provisions of the Harrelson law were explained by Commissioner Wilson and Paul Grabel, editor of "Arkansas Highways," and local problems of road building as affected by the new law, there freely discussed. There was, however, a notable absence of the hostility to the measure that had been anticipated as a result of the activities of leaders of the opposition in the extra session.

It should be remembered, of course, that Arkansas can not justly be said to have been unprogressive in road matters even before the development of the present program. In fact, an over-reaching enthusiasm for good roads, which reached its crest just

before the deflation period of 1920, had resulted in the construction of virtually \$60,000,000 worth of permanent roads.

The roads constructed during 1923 totaled 767 miles, only 22 per cent less than in 1922, in spite of the withdrawal of Federal Aid and the political yowling of road opponents. This mileage included 225 miles of dirt road, 400 miles of gravel, 10 miles of macadam, 40 miles of asphaltic macadam, 50 miles of asphaltic concrete and 42 miles of cement concrete. The expenditure on the 767 miles was \$7,250,000.

The total improved road mileage in the state at the end of the year was 4,582 miles, of which 995.61 is graded dirt, 2,656.10 is gravel, 231.10 macadam, 22.70 surface treated gravel, 45.89 surface treated macadam, 188.91 asphaltic macadam, 284.39 asphaltic concrete and 148.27 cement concrete.

But these roads were scattered throughout the state, and not linked up into an effective state system. It was this over-enthusiasm, improperly financed by placing the burden exclusively on lands through which the highways ran, that resulted in the reaction, the dissatisfaction and the unrest which

proved such fertile soil for the unsound and radical thought which in 1923 came so near wrecking the entire program.

Now, however, through a redistribution of the bond burden upon the shoulders of the



Above is a view of the Arkansas-Missouri Highway running from Little Rock northeast to the Missouri line, just north of Judsonia. At the left is one of the picturesque hair-pin loops on the State highway, running from Russellville to the Diamond Cave at Jasper, through the mountains of Newton County. At the right is a picture of the "Gleason cut-off" on the Little Rock-Fort Smith Highway, four miles west of Conway, as it appeared before the Highway Department started to make it a passable "all-weather" road.



A typical, beautiful stretch of countryside on the Little Rock-Port Smith Highway between Ozark and Mulberry is shown above. Truly

it is a "pleasant road through a pleasant land." In the insert is shown another view of the Little Rock-Port Smith Highway in Franklin County.

road user (through the gasoline tax), the basis for most of the dissatisfaction has been removed, and the future financing of road maintenance and bridging of gaps in the system have been provided for.

In the future, under the new law, no permanent road district can be formed until a majority of the land owners affected desire it and so signify at an election. Nor can the land owners burden themselves for more than one-half the total cost of the improvement. Nor can they build a road that does not fully meet the engineering requirements of the Federal government and the state highway department.

On the other hand, all the roads in the state system of 6,700 miles, connecting every county seat in the state, and traversing it in every direction, are to be from henceforth maintained by the state under the patrol system. They are never to be permitted to deteriorate for lack of care, as has happened so often in the past.

For administrative purposes, Commissioner Wilson and Engineer Limerick, with the advice and consent of the honorary commission, have divided the state into six districts, each with approximately 1,100 miles of road.

Road crews and patrols are at work in every county in Arkansas, patching, reconstructing, resurfacing, regrading, re-ditching, installing new culverts and drainage structures and otherwise raising the standards of the system. Dangerous curves are being eliminated,

where possible, or safeguarded by adequate guard rails.

A state system of road signs is being erected for the guidance of tourists.

Camps for the motorists are also being organized, and in this work no agency is doing more effective work than the Arkansas-Louisiana Automobile Association, of which E. S. Lockett, Sr., is president. Mr. Lockett has visited and held community meetings in more than 40 towns and cities, and plans to cover the state in the near future. It is planned to have every city and town on the state primary and secondary system establish a tourist camp, through which the community and the state may be advertised to the motor touring public as both progressive and hospitable.

A "log" of state roads, similar to the national blue-book, is being prepared for free distribution, and a state bulletin, "Arkansas Highways," is being issued monthly for the information of the taxpayers and the maintenance of proper sentiment toward the good roads program. Progress maps and tourists maps are being distributed regularly, and additional information of value to taxpayers and the general public is being compiled.

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One Good Turn!

"What," we asked of an honest automobile dealer, "is a complete overhauling?"

"Well, in the case of a used car taken in on trade," answered the honest dealer, "it means turning back the speedometer."

Keep Off the Accident Map

An interview with COL. D. C. WINEBRENER,
State Road Commissioner of Maryland.

By J. M. ALVEY.

How and where automobile accidents on the highways occur and the methods employed in the tabulation and study of them by the road commissioners of Maryland is herewith briefly told.

IN the office of the Maryland State Roads Commission at Baltimore hangs a great map of the highway system of the state. Unlike the ordinary road map, however, this map is dotted with little pegs, each of which marks the scene of a motor vehicle accident on the state roads.

The object of the accident map is to aid in tabulating and studying accidents with respect to the kind of road on which they take place, whether on grades, crossings, curves, in towns and villages or in the wide, open places.

Colonel D. C. Winebrener, State Road Commissioner, in reply to a question—put to him in a recent interview—as to where the most accidents occur, said:

"Most accidents happen on the apparently safest roads. You can't build a foolproof road.

"At first thought one would suppose

that most accidents happened at 'death curves,' on bad railroad crossings, in congested districts, or in the mountainous country, but such is not the case. The accident map shows that a large percentage of fatal accidents take place on straight, wide roads. Most everyone is careful on dangerous highways but there are many, far too many, who throw carelessness overboard when they come to a fine, wide 'safe' road. Speed and failure to be on the alert and careful cause most motor wrecks.

"It has also been noted that city people figure in a high percentage of smash-ups in the country. Being held down all week by traffic cops, street cars, jams of traffic and crowds of pedestrians, the city motorist feels like cutting loose and not merely 'stepping on it' but standing straight up on it, when the open roads loom ahead on Sunday afternoon."



The accident map of the Maryland State Roads Commission. The black dots show where an accident occurred and the white dots show where the accident resulted in death.



The intersection of Irvin and Myrtle Streets, Hanford, California, before and after the installation of an Armco part-circle culvert, which is fully described in the following article.

Another Wet and Dry Issue

California towns place themselves in the dry column in respect to street crossings.

THE citizens of the little town of Hanford in Tulare County, California, may not be agreed as to the merits of the Eighteenth Amendment or of the Volstead Act, but they are all through arguing as to the respective merits of wet and dry street crossings. On this issue, the dries have won by unanimous vote.

On some of Hanford's streets, up to a short time ago, the effort had been made to care for the drainage at crossings by means of swales or "dips." The theory was that the pavement could be sloped so gradually to these open gutters that no serious jar would be experienced in crossing them, and that such a construction would save considerable expense by making culverts unnecessary.

In practice, however, the "dips" have proven highly unsatisfactory. They do form serious obstacles to vehicular traffic and have been responsible for many ruined tires and broken springs. For heavy and fast-moving vehicles such as fire engines and hose wagons and police and ambulance cars, they are sources of hazard and delay that have been found intolerable. They are responsible also for a large number of minor accidents to cars and pedestrians through their retention of mud and water which is

afterward splashed and sprayed on nearby portions of the pavement. In this way the corners (the very places where safety should be most carefully guarded) are kept wet and slippery long after the remaining portions of the streets are dry. The result is that numerous skidding mishaps occur, and both passengers and pedestrians are endangered.

A less serious consideration, but one that has undoubtedly had much to do with the change in public sentiment, is the inconvenience to foot passengers caused by these open ditches which,



A wet crossing in a California city. "In practice, however, the 'dips' have proven highly unsatisfactory. They formed serious obstacles to vehicular traffic."

during the wet season, form long, transverse puddles at every block. One not provided with boots or goloshes can hardly travel far dryshod. Yet worse is the experience of the luckless stroller who happens to reach the curb at a crossing just as a rapidly driven car negotiates the turn. Unless he is a decidedly artful dodger, he is likely to emerge from the resulting cloud of spray with an urgent errand at the cleaners. On such occasions even the soberest of citizens have been heard to use "language."

From an engineering viewpoint the depressed crossing has proven a total failure. The jar or jounce of the cars and trucks as they strike the lowest point of the hollow is too great a strain for the concrete, so that the gutters quickly crack and ravel out. This tendency is clearly shown by one of the accompanying photographs. Thus the open gutters, far from being an economy, show themselves a source of added expense through the necessity for early reconstruction.

A safe, certain and lasting remedy for this state of affairs is provided by the Armco part circle culvert. This consists of a series of corrugated arches set between angle irons in a base of con-



The west side of Seventh and Harris Streets, Hanford, California. Note the angle of the automobile as it enters the dip formed by the gutter

crete. Two of the photographs show the conversion from wet to dry of some of the worst crossings in Hanford. Similar changes are being carried out in other cities where the "dips" were installed a few years ago, and the new construction, with its continuously level pavements, meets with practically unanimous approval. Now that Armco ingot iron is available for this purpose in No. 8 gauge (11/64 inch) many situations can well be cared for in this way where this type of culvert would otherwise not be practicable on account of the width and lowness of the arch.

Any person who has ridden through the streets of a town before and after this change was effected needs no argument whatever to convince him that it constitutes an improvement altogether out of proportion to the moderate cost involved.

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Very Provoking

A negro was receiving bricks at the top of a ten-story building in Los Angeles, where some repair work was going on. Another negro on the ground was loading the bricks on the carrier. The negro above accidentally dropped a brick, hitting the one on the ground squarely on the head.

He was very indignant and yelled to the one above: "Be a little moah careful up thar, nigger. That brick hit me and made me bite muh tongue."



East side of Seventh and Harris Streets, Hanford, California. The installation of a part-circle Armco culvert has eliminated the dip gutter, leaving the corner smooth and dry during wet weather.

The Victory Highway---A Transcontinental Memorial

By H. G. WEST,
President, The Victory Highway Association.

The building of a road through a lake, and the voluntary raising of money by popular subscription in one state to aid in the financing of a road in another, are among the unusual features connected with the building of the Victory Highway. These and other interesting facts are herein briefly told by the president of the organization responsible for the creation of this practical memorial to the men and women who served in the World War.

IN the summer of 1921, The Victory Highway Association was organized and incorporated under the laws of the state of Kansas, for the purpose of developing the Victory Highway as a national memorial to those men and women who served their country during the World War.

It was the association's desire to choose the shortest distance between New York City and San Francisco, selecting those roads which were either already paved or which were likely to be the first improved.

From New York City to St. Charles, Mo., a line was selected which was all paved with the exception of a few miles of gravel in New Jersey. There confronted the association the roads of Missouri, famed for their sticky mud; and those of Kansas with little or no paving. Colorado was in a far better condition than many other western states in the matter of roads, and showed a very good line of gravel across the

state. California roads were the best of all, although the line adopted by The Victory Highway Association from the state line to Sacramento was not paved. Utah and Nevada roads were problems to motorists, who encountered all kinds of hardships in crossing the desert, there being only a track across the sands for long distances through Nevada.

In the stretch over the Great Salt Lake Desert in the western part of Utah, the engineers met one of the most unusual problems in road construction in the United States. For three months of the year the forty-mile section which the Wendover Cut crosses is covered with water anywhere from six inches to two feet deep. The water apparently rises from the ground itself, and in the vast desert which comprises the western portion of the state, becomes an inland sea of no appreciable depth but of seemingly limitless expanse.

The waves which are stirred up by the winds are the force which the engineers



Section of the Victory Highway in crossing the famous Berthoud Pass in Colorado, showing the old and the new road.



A 24-inch Armco culvert under the Victory Highway in Contra Costa County, California. This culvert was installed in 1910 and after 14 years of service is in excellent condition.

had to overcome. The water carries a heavy solution of salt which when deposited on a permanent embankment hardens and provides a superb traffic surface, but unless the embankment is protected the waves will gradually tear it away. A "sea wall" of planks was found to be the most effective protection against this wave action, and the Wendover Cut-off of the Victory Highway when completed will be simply a low embankment, wide enough for two cars to pass, flanked on each side with such a bulwark.

The Utah state highway commission, together with Governor Charles R. Mabey, is arranging for having moving pictures of the construction work on the Wendover Cut-off taken. The pictures will show a road building operation unique in the history of the country.

About the time of the formation of the organization, Senator L. C. Phipps of Colorado, drew up a bill providing for Federal aid, and when Congress passed it, Mr. Ben Blow, Vice-President and Manager of The Victory Highway Association, with many years of good road work in California backing him, selected a line from St. Charles, Mo., to the Pacific coast, which he believed would be most likely to receive Federal aid, and therefore most quickly im-

proved. That Mr. Blow was right in his contention is shown by the fact that from St. Louis to San Francisco, the Victory Highway comes within the primary system of Federal aid, which, of course, insures its early completion.

Missouri is rapidly paving the line of the Victory Highway passing through that state, and to date has completed a large percentage of it. Mr. Theodore Gary, Chairman of the Missouri State Highway Commission, is creating a precedent for all highway work in building this road, in that he has selected a line across Missouri without regard for towns, which is considered the shortest possible line between St. Louis and Kansas City, being 256 miles in length, 23 miles shorter than any railroad.

Kansas has paved the greater portion of the Victory Highway to practically the center of the state.

Colorado has made big improvements on the portion of the Victory Highway within its boundaries. This highway is now graveled the greater portion of the distance across the state. With wide mountain roads of easy grades, it runs through wonderful scenic country.

The construction of the Wendover Cut-off in the western part of Utah, which the Victory Highway Association decided was the shortest and most feasible route across the Great Salt Lake Desert, was made possible by the donation of \$50,000 by cities of northern California.

So far as is known, this is the first instance in which one state has helped a neighboring commonwealth with its road work.

And now the same section of California is raising another \$50,000 to give to Nevada for a like reason. Last year Nevada made big improvements on her roads and they are no longer the terror they once were to tourists. Only three short links of the Victory Highway in this state remain unworked, and with Federal aid now made available for them, they will soon be a pleasure to drive over.

California is hard-surfacing the unpaved portion of the Victory Highway and within another year, this highway will be over improved roads for the entire distance across the United States.

Save the Forests---Protect the Highways

By H. T. GISBORNE,
Priest River Forest Experiment Station, U. S. Forest Service.

Alert, trained fire fighters of the United States Forest Service constantly seek not only to locate and extinguish forest fires before they gain headway, but to learn the exact causes of these fires and the most effective ways to prevent them. The inter-relation of good roads and forest protection is shown in the following article.

WELL graded, well surfaced, well drained highways through the virgin forests of the United States have a cash value which is only beginning to be generally realized by the public. Certain localities on the routes of heavy tourist traffic are now paying special attention to this fact, and are putting their roads in excellent condition.

In California, Oregon and Washington, at least, the value of the timber border along the highway is now so well recognized that narrow strips of trees bordering certain roads have been purchased from lumber companies and spared from the axe. With the danger of the axe eliminated, however, there still remains one menace of even greater importance. And that menace is fire, fire started by the very tourists and users who most enjoy the green timber, and

for whom that timber-bordered road has been graded, surfaced and drained.

At the Forest Experiment Station, maintained by the United States Forest Service at Priest River, Idaho, the danger and chances of fire in the forest are now being studied intensively.

Numerous tests have been made of the inflammability of certain materials such as grass, weeds, punky wood, and the forest duff composed of the dead tree needles and leaves covering the soil, which all vary in their reactions to weather conditions.

Similar experiments have also been made by the forest fire specialists in California and by the Wind River Forest Experiment Station at Stabler, Washington.

In California and in Idaho the reactions of some of the heavier materials have been studied and the amount of



An example of the desolation that meets the eye of the motorist all too frequently. This particular scene flanks the highway on the upper St. Regis River in Montana. Courtesy U. S. Forest Service.



A highway that is beautiful as well as serviceable. This cool forest-bordered road is in Lincoln County, Montana. Courtesy U. S. Forest Service.

moisture in the material which prevents inflammability has been fairly well determined. Forest duff, for instance, is practically fireproof if 100 pounds of the material is holding 25 pounds or more of water. With a 15 per cent moisture content a blazing match or a cigarette stub will only rarely ignite the duff and cause a fire, though great care is necessary in case of a camp fire. If, however, the duff dries out to a moisture content of 10 per cent or less, then a match or a cigarette thrown out of a car speeding along the highway is very liable to set it on fire. This extreme danger from matches, cigarettes and campfires usually lasts for from twelve to sixteen weeks during the driest part of each summer, and it is during this small portion of each year that a very large proportion of the fire losses occur.

Nearly all forest highways are also bordered by windfallen or chopped down trees which were not disposed of when the road was constructed, and which are now slowly rotting. This rotten wood has been found at the Priest

River Station to be one of the most dangerous of all materials for catching, holding and spreading fire.

Foresters and timber owners are not the only ones interested and affected by the campaign now being waged for the application of care with fire in the woods. The tourist auto-camping across the country is sure to have certain parts of his trip completely spoiled when he encounters either long stretches of burned timber lands, or when he runs into an actual fire raging beside the road and perhaps preventing further progress. Likewise, he is always in danger, whenever he camps in the forest, of being burned out while he camps, as a result of his own or some one else's carelessness with a campfire. Gradually these dangers are being reduced as people appreciate more and more the extreme danger in a single live spark, match, or cigarette stub.

But the highway engineers and county officials responsible for our wonderful roads are even more vitally affected by this fire menace. They know, better than anyone else, how the cost of maintaining a road increases after a fire has swept a long stretch of it, leaving deadened stubs to fall over and block the road and its drainage ditches. They also know that the extra money spent on removing these windfalls must usually be taken from some other stretch of road where much needed improvements had been contemplated. They know, too, that in those counties in which National Forests are located there is a Federal fund devoted to roads and schools each year amounting to 25 per cent of the gross revenue of the National Forest area in that county. The taxpayers in such counties know that their taxes are lessened and their roads in better shape as a result of the expenditure of these funds. Fire kills the forest that must provide those funds, hence the roads and schools must do without this money or the taxpayer must make up the deficiency.

Fire blocks the roads and ditches, destroys bridges and culverts, and raises the cost of highway maintenance. Fire turns a cool, green drive with inviting camping places into a dirty, desolate stretch of road to be hurried over or avoided if possible.

How an Oregon County Saved a Million Dollars

An interview with W. J. CULVER,
County Engineer, Marion County, Oregon.
By CHAS. J. LISLE.

A good wide foundation, thoroughly drained, is absolutely essential in successful road building, according to W. J. Culver, who has saved a million dollars to Marion County, Oregon, through his capable direction of its highway building program. At his suggestion the county purchased complete paving equipment, which was operated almost entirely by taxpayers of the county.

IN Marion County, Oregon, where altitudes range from 100 feet to more than 7,000 feet above sea level, and the conditions vary from flat alkali desert to the densest virgin timber and the most precipitous rocky canyons, there are 1,239.65 miles of roads and four miles of recognized mountain trails. For twenty years the county graveled its public roads and now has 614.45 miles of plain gravel highway. A few years ago the building of macadam roads was begun, and there are now 185.75 miles of this type of road.

In 1915 the county court began experimenting with hard-surfaced roads. One experimental section of three miles was laid and given a three-year test. By 1918 the public was well enough informed on the question to be ready for a bond issue of \$850,000, which was voted by a tremendous majority.

These bonds were voted in connection with the state Market-Roads law, a



Marion County, Oregon, has proved that economically paved roads make farms more valuable.

measure presented by State Senator Walter M. Pierce, now governor of Oregon. Under it the state appropriates through direct taxation a sum equal to any county appropriation for important belt line or market roads. This gave Marion County \$1,700,000 for the proposed five-year program. The county court called in representative delegates from every part of the county to agree on the location of the roads that the total appropriation could build. Some of the locations might possibly have been better, but in general the plan worked surprisingly well.

Engineer Culver was then put in charge and entrusted with the spending of the \$1,700,000. He had officially surveyed almost every mile of the more than 1,200 miles of roads; he knew them by heart. He had his plans laid out long before the call came to begin on the big program. Included in them were provisions for having the county buy and operate its own plants, the use of a



One of the four paving plants which Marion County built in a campaign to save a million dollars.



A steam roller following the "hot stuff" wagon, Marion County, Oregon.

quick-setting pavement that is easy to repair, and the making of surface preparations by the county itself. They also provided for the hiring of only local men, preferably taxpayers.

Four paving plants were purchased and set up in as many sections of the county. Each plant requires about 50 men for a full crew of plant and road operators. In most sections of the county, wash gravel is easily procurable. This is crushed if necessary for the top dressing. In some places the country trap rock is used. The county also bought a fleet of trucks, of which there are now thirty, most of them equipped with hydraulic dump bodies. Some outside trucks are hired during the rush season, but only for emergency use.

The county has adopted asphaltic concrete for all its roads. This is laid on hot, and can be used for moderate traffic within 24 hours after laying. The new pavement is usually laid on the old roads that were important enough to be macadamized in the earlier days of better road building. However, the macadam has not saved much in the final construction, except that the main contour of the road is fairly well established and graded and therefore utilisable for the new. In many places, however, the old grades and curves must be improved. Since the one-way macadam is not wide enough for the new highways, which are 16 feet wide, the whole macadam deposit, including the rock base, has to be scarified and removed to make a uniform base for the new road.

These scrapings, however, help to make the fills for the better, wider road.

After the roadway is carefully graded, a layer of rubble stone, from four to eight inches in diameter, is laid in to form a base twenty feet wide. This is covered with smaller gravel and then heavily rolled to smoothness. On this a four-inch layer of hot asphaltic concrete is poured direct from the steam mixer. A spraying of hot asphalt is put on after the final heavy rolling. This is followed with a layer of sand to bind in with the hot asphalt.

The rental of plants and the purchase and upkeep of trucks and road machinery are paid for out of the county general fund, but are charged back to each market road project appropriation. The machine-use charge, which is made on a flat basis of fifteen cents per square yard of paving laid, has repaid all the original machine and plant cost, and paid the expense of keeping the machinery in order. In this way the county has saved enough from its general road levy to take up the first \$85,000 installment on the bonds, due in 1924.

The county receives about \$50,000 a year from automobile licenses, this being 25 per cent of all the auto license fees paid within the county. This goes to the general road fund, which covers the bond payment, the building of large bridges, and the cost of roads and trails in the mountain districts where there is not enough taxable property to build and care for the roads.

Besides the 100 miles of market roads already paved, and the other 25 miles to



Cutting up fields to cut down grades. Laying out a new highway through a wheat field in Marion County.



Another of the four paving plants which helped Marion County save a million dollars. This plant is owned by 55,000 citizen-partners.

be paved during 1924, the \$1,700,000 bond and state fund will pay for another 50 miles of road grade, drained and ready for later paving. The general practice is to grade at least a year ahead of the paving, so as to have the roadway thoroughly settled before hard-surfacing.

"The real road is almost all underneath, where you don't see it," said Engineer Culver. "Drain your ground thoroughly; lay a good wide foundation, and roll it until it is twice as solid as you thought you could get it; then the top will take care of itself. That's really all there is to it.

"The longer we work, the more we stress the importance of a good foundation. We now build a roadbed that would carry the traffic even without the top-surfacing; when the top is laid, we have a road that will endure. We shall have better roads when the bonds are paid off than they are today, because the foundation is right.

"There may be places where competitive bidding on public works will bring better results than for the county to carry on its own constructing. It has not been so with us. I do not mean to infer that contractors combine to fatten off the people; but I do know that already we have saved our county a million dollars, and that at this rate our total saving, if we were to pave all our roads, would be more than twelve millions.

"Hiring taxpayers who themselves have to pay the taxes, makes it a partnership deal all around. We have as many as two hundred of them at work during the building season. All draw

partnership profits besides their wages; for if we can cut our paving bills fully forty per cent and lower our taxes that much or get that much more road for a given sum, all that we save is our own.

"Everywhere there is a cry of excessive taxes. We have it with us. But our people have supported our road program splendidly. It isn't that they are richer or more spendthrift than other frugal communities; but they see that we are getting honest results with their money."

Comparisons of costs with similar construction both in and out of the state, show that the county has easily saved \$10,000 a mile on its present cost of about \$15,000 a mile for all the engineering, grading, and final paving. The 100 miles already laid has thus netted the county a million-dollar saving; and the 25 miles yet to lay during 1924 under the original program should show another quarter of a million of savings.

The national highway bureau shows that in the 2,830 counties in the United States there is a total road mileage of 2,941,294 miles. Marion County with 1,243.65 miles of road and trail has 20 per cent more than the average mileage and three times the average county area, with only a sparse population to pay its bills. There is in the United States 387,760 miles of roads surfaced in some manner—paved, macadamized, graveled; only a little more than 13 per cent of all the roads being surfaced in any manner whatsoever. Marion County has 937.20 miles or 76 per cent paved or surfaced, almost six times the average for the country over.



Irrigation and Drainage

Details of Don Pedro Dam

By DANIEL McFARLAND, Civil Engineer.

Where nature has neglected to provide sufficient rainfall for extensive regions of fertile soil, man steps in and dams the streams that water may be made to flow over the arid acres whenever needed. Some idea of the size of these great structures may be gained from the following description.

MILLIONS of acres have been added and millions more are being added to the fertile fields of this country by storing the waters of rivers and streams in great reservoirs and directing it over the surrounding land at regular intervals. Some of the largest and most profitable of these irrigation projects have been developed in California, the first state to have an irrigation district law. This law, known as the Wright Act, in honor of C. W. Wright of Modesto, who sponsored the law as passed in 1887, has been the basis for the irrigation district laws of all the other states.

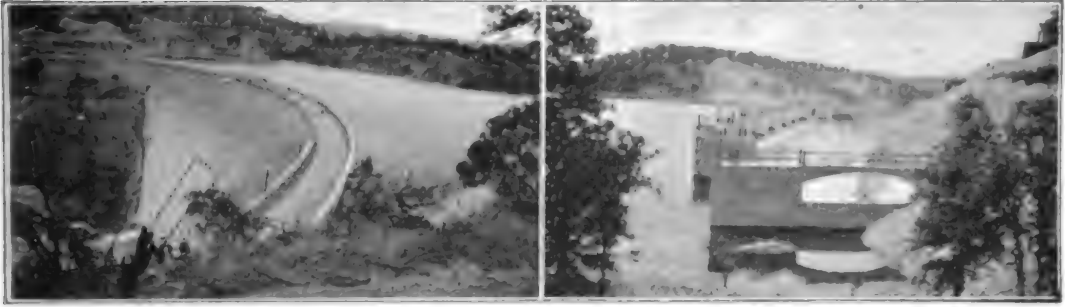
Two irrigation districts, the Modesto and the Turlock, were organized shortly after the enactment of this enabling legislation, and it was to provide more water for these San Joaquin Valley projects that a four million dollar dam was begun in 1921 on the Tuolumne River, about eight miles east of La Grange.

This dam, the Don Pedro, as completed, is 283 feet high, 176 feet wide at the base and 16 feet wide at the top. The arch of the dam, which is upstream, has a radius of 675 feet. The upstream face is practically vertical, while the downstream face has a slope of about 6 to 10.

Eighteen outlets or gates in the dam

Two views of the Don Pedro Dam. The upstream face of the dam (left) is practically vertical while the downstream face has a slope of about 6-10.





At the left is shown the 16-foot roadway across the top of the dam, which enables tourists to get a good view of the lake above, formed by the Dam. The Dam is 283 feet high and 176 feet wide at the base.

control the amount of water that is used in the power house and also that used for irrigation. Enormous valves, each weighing about twenty-five tons, control these gates. They are operated by water pressure, so that one person may turn a lever and release or shut off a vast amount of water. In order to permit of the inspection of these valves, there are galleries at three different levels with connecting stairways.

A roadway 16 feet wide across the top of the dam enables visitors to get a good view of the lake that has been formed above the dam.

Some idea of the vast amount of material required for this great dam, which is 1,000 feet long, may be gained from the fact that there are 300,000 cubic yards of concrete in the dam, spillway and power house. To bring the material

to the site of the dam, a temporary railroad was built, which in itself is of particular interest. It was so constructed that at the completion of the dam, which required two years to build, practically all of the material, including the trestle timbers, was taken down with little loss.

The most unusual feature, however, was the manner in which the Armco corrugated culverts for draining the roadway were installed. Instead of their being placed near the bottom of the fills, as is customary, they were installed near the top, so that they could be removed with the minimum of excavation. The great tensile strength of the Armco culverts made this type of installation possible, and thus considerable economy was effected.

Below at left is shown the temporary railroad built to bring material to the site of the Dam. It was drained with Armco corrugated culverts, which were salvaged along with the tracks when the dam was completed.



Solving a City Drainage Problem With Metal Flume

By L. C. VANCE, Superintendent,
Light and Water Department, Vidalia, Louisiana.

The south half of Vidalia, Louisiana, on the Mississippi river is too low to drain naturally into that stream. How the water was conducted to a large well and then pumped into an Armco flume extended out over the levee is described below.

INGENUITY and good judgment will furnish a satisfactory solution for almost any problem, ingenuity providing the general idea and good judgment determining how it shall be carried out in order to be practical and lasting. These two qualities were both displayed in solving the drainage problem of Vidalia, Louisiana.

This town of 1,500 people, which is located on the Mississippi river directly across from the city of Natchez, Mississippi, is divided into two sections by an east and west ridge. The section to the south of the ridge has natural drainage, but that to the north has no drainage below the level of the streets.

About a mile from the center of the town, and two miles from the city power plant, is the lowest point north of the ridge. Here a pond has formed into which drains the rain and seepage water.



An inside view of the Armco flume installation at Vidalia, Louisiana, described in the accompanying article.



A view of the Armco flume which carries drainage water over the levee into the Mississippi River, at Vidalia, Louisiana.

A small drainage canal was dug from this pond to a point near the levee, where a well was dug and lined with brick. This well, which is fifteen feet deep, is twelve feet wide at the top and tapers to eight feet wide at the bottom.

A 12-inch Lawrence pump of the centrifugal type was first installed to pump out of this well, and later an 8-inch American centrifugal pump was added. The 12-inch pump is capable of handling 5,000 gallons of water per minute when operated at a speed of 500 R. P. M. It is located 12 feet above the lowest stage of the water in the pond, and about two feet above the highest stage. It is run by a G. E. variable speed induction motor of the latest type, 2,300 volts, 3-phase, 60-cycle, with overload and underload automatic switch release protected by automatic ground control, double set fuses, and lightning arrestors. The 8-inch pump is set directly over the well on two 12-inch wrought iron pipes set in concrete. This pump is direct-connected to a 15 H. P., 110-volt single phase motor of the Wagner



"Directly above the house and at the end of the discharge pipes from the pumps, the flume structure begins."

make. The 12-inch pump is belted to the 75 H. P. G. E. Motor.

All this pumping machinery is well housed in a galvanized corrugated house having a wooden floor, and all pumps and motors are set on concrete foundations.

Directly above the house and at the end of the discharge pipes from the pumps, the flume structure begins. This flume is 72-inch Armo half circle made by the Dixie Culvert Manufacturing Company of Little Rock, Arkansas.

The flume from the discharge of the pumps to the levee is about 120 feet long and from the levee to the river is about 100 feet. It is set in a wooden all cypress foundation, and this foundation rests on concrete block posts.

The posts are 4-inch by 6-inch, and the runners for the flume are 3-inch by 6-inch. All the wood work was put up according to the blue print furnished by the Dixie Culvert Manufacturing Company.

The flume at the discharge pipes is 14 feet high and at the levee end 12 feet high, giving us a drop of 2 feet to 120 feet in length. This was done in order that additional pumping machinery might be installed without adding another flume. I believe that this flume will handle about 10,000 gallons of water per minute on this construction.

The levee end of the flume is about $3\frac{1}{2}$ feet above the levee, with the same slope as the levee. It is made in sections so that when the river comes up one of them may be taken off. These sections are ten feet long. The water

from the top of the levee comes down with such force that when the river is up the flume would have to empty in the water to keep from cutting the levee. When the river is low we run this water away from the base of the levee so as not to cut in the earth at the levee base.

This flume, and in fact the whole installation, has proved very satisfactory in every way, and since we have had it we have not been bothered with overflow from rain and seepage water.

The construction of the foundations and the installation of the pumps, motors, etc., was all done under the supervision of the writer.

◆◆◆◆◆

Delicately Nurtured

It was a hot day and seven cars were waiting their turn at a filling station. The last one was a steaming little 1915 Rattler, with six rattles and a button. Finally it got its turn and the peevish attendant yelled:

"How many gallons?"

The driver of Lizzie held up one finger.

"Say," bellowed the attendant. "What are you tryin' to do? Wean it?"



"The flume from the discharge of the pumps to the levee is about 120 feet long and from the levee to the river is about 100 feet."



Does Iron Burn? Certainly!

PUT a white-hot iron nail under a bell full of oxygen and it will burn brightly and rapidly, leaving a little heap of ash called oxide of iron.

Leave an ordinary nail exposed to our atmosphere and it will burn just as surely, though it will take much longer.

When the process is completed you will have a heap of oxide of iron, commonly called "rust."

"Burning" and "rusting" are similar except for the element of time.

Our fire losses in 1922 were \$521,860,695.00. The cost of replacing rusted-out metal during the same period topped this figure by more than a hundred million dollars!

Every industry and every home pays a yearly tax to rust. Much of this waste can be prevented. Whether you are a business man or a housekeeper you should know a few simple facts about rust.

What causes rust?

Ordinary iron and steel contain sulphur, silicon, phosphorus, carbon, manganese, and other impurities.

When exposed to air and moisture, these foreign substances set up electrolytic action, which eats away the metal. That is rust.

Armco Ingot Iron is the result of scientific effort to reduce this destruc-

tive process to a minimum by practically eliminating these impurities. Many exacting service records prove its durability.

How Ingot Iron protects your business and your home

Architects, engineers, and fabricators of metal are quick to appreciate the "old-fashioned" purity of Ingot Iron.

Because of its extraordinary lasting qualities, its great ductility, and its ability to take on a purer zinc coating, Ingot Iron is constantly specified for roofing, siding, window frames, ventilators, skylights, rain gutters, down spouts, tanks, culverts and other building purposes where durability counts.

The fine-grained, uniform texture and smooth surface of Ingot Iron, make it the ideal base for vitreous enameling and zinc coating.

Look for the Armco label

You can identify articles manufactured of Ingot Iron by the blue and gold Armco label. This label is your guarantee of excellence and endurance. Ingot Iron in sheet form can be identified by the blue Armco triangle, stamped on every sheet before it leaves the mills. It will pay you always to look for the Armco trade mark.

THE AMERICAN ROLLING MILL COMPANY, Middletown, Ohio

A SEVERE TEST OF INGOT IRON

At the left are shown Ingot Iron buildings of the Tata Oil Company, Limited, at Tataperam, Cochin State, India, which have been subjected to the most trying conditions for three years and show no signs of deterioration. In a moist, rust-

promoting climate where the average humidity is 88% and the average rainfall 120 inches, this record is a most convincing demonstration of Ingot Iron durability.

ARMCO
INGOT IRON
Resists Rust





For— ROAD BUILDING and MAINTENANCE

"Our Bests are used for all kinds of road building and road maintenance as well as rock crushing," a road superintendent writes. "I find that they will do any job that we have, and we save money by using them in place of horses to do all kinds of road work. We have two 'Thirties and two 'Sixties.'"

It will pay YOU to investigate the advantages of Best Tractors. Send for a list of nearby owners and let their testimony—man to man—convince you.

Send for a copy of the new Best Tractor Catalog.

It contains details of construction showing why Best Tractors can perform so well.

C. L. BEST TRACTOR CO.

General Offices—Factory
San Leandro, California

Factory Branch—Warehouse
St. Louis, Missouri

Sales Offices

San Francisco
127 Montgomery Street

New York City
30 Church Street

BEST TRACTORS



*by
a man who
looked
under the
roads*

Gentlemen:

A few days ago I made a trip over a road in southern Arizona, which I constructed as resident engineer for the old Territorial Highway Department in 1910 and 1911, and on which a quantity of ARMCO Culverts were used.

In making the trip I was curious to know how these culverts would appear after some 13 or 14 years' service, so I examined a number of them.

I found them in excellent condition—galvanizing intact—rivet heads bright. The only sign of rust was on the bottom of the first half dozen corrugations of a few of these culverts, and this proved to be only sur-

face rust, for when scraped lightly with a knife the metal showed bright below.

All of these culverts have had to stand considerable abrasive action since their installation, as the road is in a district subject to cloud-bursts and heavy erosion of sandy soil. Also, all of these culverts get a considerable hydraulic head which makes the flow much faster through them than under ordinary conditions.

I was more than pleased with the condition of these culverts so long after their installation.

Very truly yours,

E. C. DIETRICH, City Engineer,
Tucson, Arizona



ARMCO CULVERTS

Look Under Your Roads for the Proof

Armco Culvert & Flume Mfrs. Association

215 N. Michigan Ave., Chicago, Ill.

2-100
45 cop 2, v H found

The **HIGHWAY MAGAZINE**



September
1924

**Write to the nearest manufacturers for particulars
and prices on ARMCO Ingot
Iron Culverts**

Arkansas, Little Rock
The Dixie Culvert & Metal Co.

California, Los Angeles
California Corrugated Culvert Co.

California, West Berkeley
California Corrugated Culvert Co.

Colorado, Denver
The R. Hardesty Mfg. Co.

Florida, Jacksonville
The Dixie Culvert & Metal Co.

Georgia, Atlanta
The Dixie Culvert & Metal Co.

Idaho, Pocatello
The Burnham Mfg. Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equip. Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
Nebraska Culvert & Mfg. Co.

New Hampshire, Nashua
North-East Metal Culvert Co.

New York, Albany
North-East Metal Culvert Co.

New York, Elmira
Highway Products & Mfg. Co.

North Dakota, Wahpeton
Northwestern Sheet & Iron Works

Ohio, Middletown
The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

South Dakota, Sioux Falls
Sioux Falls Metal Culvert Co.

Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

Texas, El Paso
Western Metal Mfg. Co.

Texas, Houston
Western Metal Mfg. Co.

Utah, Woods Cross
The Burnham Mfg. Co.

Virginia, Roanoke
Virginia Metal Mfg. Co., Inc.

Washington, Spokane
Spokane Culvert & Tank Co.

Wisconsin, Eau Claire, Madison
Bark River Bridge & Culvert Co.

Canada

Canada Ingot Iron Co., Ltd.

Guelph, Sherbrooke, Winnipeg, Regina, Calgary, Vancouver, Vernon

The HIGHWAY MAGAZINE

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Old Transportation Methods Still In Use

The horse car and the ox-cart are no longer vital factors in the transportation problem of the United States, yet a few of these old relics of other days are still found in use. The horse car pictured above plies between two of the finest hotels in fashionable Palm Beach, Fla. Below: a modern mail truck is seen delivering parcel post mail to an ox-cart driver near Washington, D. C.





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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Road Bid Openings Broadcast

THE radio has been pressed into service in the state of Missouri for the broadcasting of results in the opening of bids for road construction. The state capitol is the home of one of the most powerful of the United States broadcasting stations—WOS. A microphone is installed in the senate chamber where the bids are opened before the chief engineer and members of the highway commission. B. H. Piepmeier, chief engineer, reads the bids and bidders over twice and contractors from all over the Middle West have written in indicating that they have been able to tabu-

late bids from their own offices instead of traveling many miles to be present in person when the bids are opened.

Many letters have been received by the secretary of the Missouri State Highway Department in appreciation of this method of furnishing information on road lettings.

•••••

The Engineer in Politics

AFTER the preliminary jockeying in the first two ballots for the vice-presidential nominee, the Republicans at Cleveland settled down to two men, Hoover and Dawes. The first, of course, is well known as an engineer but few know that General Dawes earned his way through college by working as engineer for a small railroad and that he went to France as Lieutenant Colonel of the Seventeenth Engineers. His major activity has been in the professions of banking and the law, but the remnants of his engineering training show through sometimes in his capabilities—and his force of expression. No mere lawyer or banker could possibly achieve such distinction in expletive and epithet.

•••••

Investigate the locality that votes against a good roads bond issue and you will find it full of hitching posts.

The most complete economic success in highway construction in any state will only be assured when minute attention to detail is carried on in every step of the work—maintenance as well as construction.



The reception of the Pan American Highway Commission by President Coolidge at the White House, Washington, D. C. The story of the inspection tour made by the Commission is told on page 9.



A fine example of a well maintained gravel road in the Cloverland region of the Upper Peninsula of Michigan near the city of Marquette.

Choosing Material for a Gravel Road

By LELAND F. JAMES

Former Instructor Experimental Engineering and Mechanical Processes
at the U. S. Naval Academy.

The life and usefulness of gravel roads which still make up a large percentage of the highway mileage built and building in the United States, is greatly affected by the wearing and cementing qualities of the material used. Widely scattered throughout the country as the natural gravel deposits are, their qualities are almost as diversified. Various methods of testing different kinds of gravel and using them to the best advantage are discussed in the following article.

“R ESEARCH by the Bureau of Public Roads has shown that a layer of sand or other similar granular material when placed over a clay subgrade will prevent the intrusion of the clay into the base course of a macadam or other stone road. Moral: A sand-clay or gravel road built for light traffic will make an excellent base for a better surface when the traffic increases. This is the basis of what is known as the stage construction policy of the Bureau of Public Roads.”

The foregoing is quoted from a message given out to the highway world by the Bureau of Public Roads. The message is significant as indicating the useful place occupied by gravel roads in a rapidly growing highway system.

At the present time gravel roads constitute a large percentage of County,

State and Federal-Aid Construction, and in those districts where good grades of the product are more abundantly distributed, they cover more mileage than all other types combined. The better knowledge had of the physical characteristics of gravel, the experience gained in details of construction, the aid of labor-saving machinery, the development of modern drainage and maintenance methods, and the more refined processes of manufacture of parts and fittings that go to make up permanent installations—these are factors which contribute to the possibility of turning out at comparatively low cost a very satisfactory highway, where traffic conditions have not developed to such an extent as to require the superior hard surface type.

The theory on which the gravel road is based is that of mixing gravel, sand,



A section of the gravel highway over Berthoud Pass on the Victory Highway in Colorado, showing dry rubble wall.

and binder on a prepared road bed, in such proportion that all voids in the material will be filled and a consolidated mass of road body secured that will stand up under the maximum weight and destructive action of the traffic to be served.

Although gravel in its natural state is so widely distributed throughout all sections of the country, its wider variation in quality renders it impracticable to give exact rules or specifications for general adoption, except possibly when it is obtained in crushed form from certain known rocks of superior quality. As a basis for best results, however, the fundamental principles of material selection, subgrade preparation and mixing methods apply in all cases.

Natural gravel as found in banks or pits, in the beds of creeks and rivers, and at the bottom of bays and lakes may be used for road building when there is sufficient knowledge of the relation existing between physical characteristics and wearing qualities to determine with some degree of accuracy the fitness of the combined product. This may in some instances be ascertained by laboratory tests, but frequently the selection of suitable material must necessarily be decided upon by visual inspection and improvised tests in the field. While there may be considerable variation in quality in the same gravel deposit, there is often some one kind of predominating rock, the hardness and durability of which is either known or else capable of being

judged by hand hammer tests applied by an experienced inspector.

The results sought in the completed road structure being a wearing surface of high abrasive resistance to take the direct wear and tear of traffic, and a consolidated bonded mass as a foundation to receive and transmit traffic loads, it is apparent that as first requirement all of the ingredients entering into the structure should be sound and of a hard durable quality. These ingredients include: (1) gravel proper, or coarse aggregate, varying in size from a minimum of $\frac{1}{4}$ inch to a maximum of from 1 inch to 3 inches,—the maximum size depending upon the designed body thickness, the quality of the product, and the nature and quantity of the traffic expected,—the best current practice seeming to discourage the use of sizes larger than $1\frac{1}{2}$ inch, especially in the surface course; (2) sand, in which the particles are sized from $\frac{1}{4}$ inch down to a fineness that would ordinarily be retained on a 200-mesh sieve, and in such proportions as to fill the voids in the gravel; (3) clay, or other fine grained binder in such quantity as to fill the voids in the sand, and of such quality as to securely bond the several ingredients together into a dense consolidated mass on the previously prepared subgrade.

The ratio of coarse to fine aggregate is usually about 6:4, but this may have to be varied—the main consideration in



A beautiful stretch of well maintained gravel road in the Rocky Mountain region where the traffic demands are insufficient to warrant a hard surfaced road.



In the mountains in the neighborhood of Grant's Pass, Ore., a great deal of real road construction is taking place. The above photograph shows the unsatisfactory and poorly drained road to the left of the new grade that has been properly gravelled and drained.

this regard being to fill the voids. If the run of the supply source contains particles larger than the maximum size permitted for use on the road, these particles should be sorted or screened out; or, if present in sufficient quantity, it may be ultimately economical to crush them to proper size for mixing in with the more inferior run of the formation. There are several makes of small crusher plants on the market and one of these can very often be advantageously installed either at the source of supply or conveniently near the work.

IMPORTANCE OF SCREENING

Excess of fines should be screened or washed out. Washing is expensive, and in cases where the product cannot be used without resorting to this process, it may be better to seek another source of supply, although it is always well to give due consideration to advantages to be derived from proper washing and screening. A small portable screening plant may be carried as a part of the field equipment and brought into service as occasion requires, the size of the plant depending upon the nature of the supply and extent of the project. Also, conditions may be such as to justify the use of one of the lately developed plants which combines in one all the features of crushing, screening and washing.

Material surveys have been made in several states, and where these have

been conducted to such an extent as to test out representative samples taken from the deposits, builders are at once aided in material selection. A stretch of road that has been built from gravel taken from a similar deposit will in many instances serve as a valuable guide.

The binder most depended upon is clay which usually exists as a part of the formation, or, if absent, it is added in such quantity as needed when the ingredients are mixed on the roadway. In this connection, however, it should be kept in mind that in all cases where it is intended at some future time to hold the gravel foundation for a superior type of hard wearing surface, it is highly desirable that a stronger cementing or binding substance than clay be used in the original construction. Some rocks—limestone and several other varieties—are of natural cementing value, holding their own binding material as an inherent property; and where the added expense of shipping in gravel in its crushed form is justified, a superior product can be obtained, and the entire problem of selection is simplified. The rock from which the gravel is crushed may be chosen with special reference to superior wearing qualities and high cementing value, as previously ascertained by standard tests, and the grading as to sizes may be definitely specified. Or a combination of natural and crushed gravel may be used to advantage in securing a higher grade of mixture.

A Highway That Was Once a Railroad Bed

How Valverde County, Texas, utilized an abandoned railroad bed in the construction of a county highway, thereby securing a particularly good road and at the same time effecting a great saving in both time and money.

TEXAS, because of its immense extent, has a road building problem peculiarly its own. The Lone Star State has an area of 265,896 square miles, which is greater than that of the states of Michigan, Wisconsin, Illinois, Iowa and Indiana combined. But its population was only 4,663,228 in 1920, a density of only about one-half that of the average of the United States as a whole.

Within the state are 128,900 miles of public roads, 12,500 miles of which are surfaced. To build and maintain adequate modern highways in so great an area with the limited population to carry the burden requires the exercise of ingenuity and resourcefulness, qualities which were displayed in the building of a road in Valverde County, located in the southwestern part of the state and bordering on the Rio Grande River.

The main east and west line of the Southern Pacific Railroad is located in

the southern part of the County. Some years ago the railroad company changed its crossing over the Pecos River, moving the new line several miles to the north and crossing the river on a very high bridge.

While County Judge W. F. Littleton and Mr. G. M. Jowers, County Highway Engineers, were scouting the western part of the county for a location for one of the county's new highways, they decided to use this abandoned railroad grade to save money for the county.

The portion of the old railroad grade which up to the present has been used for the highway, is about four miles in length, and lies between Comstock and Langtry.

The grade was shaped up at a cost of only \$125.00 per mile. Its original width was about seven feet, but it is now 24 feet on fills. Cuts were cleaned out to a present width of 15 feet to 18 feet. Thus the county secured four miles of excellent highway at a total cost of \$500.



Part of the old cut made by the Southern Pacific Railroad, now used as a highway.



At the left is another section of the old Southern Pacific roadbed widened and graded to form the highway. At the right, reading from left to right: G. M. Jowers, County Highway Engineer; L. P. Sawyer, State Highway Maintenance Engineer, Valverde District; W. F. Littleton, County Judge; and B. A. Borroum, County Commissioner, the men responsible for the work described above.



A 96-inch Armco ingot iron culvert 35 feet long installed by the Wisconsin State Forestry Commission at Plum Lake, Wis. This culvert, which is large enough to allow the passage of boats and launches from one part of the lake to another, replaced a condemned wooden bridge.

Solving the Small Bridge Problem

WITH the development of the automobile and the subsequent unparalleled demand for more and better roads, highway engineers began to search for a more satisfactory and economical method of carrying a road over low places where there was either a continuous or intermittent flow of water. The small wooden bridge would no longer stand the strain of the greatly increased traffic weight. It was frequently washed out, sometimes burned out, and required constant maintenance. Properly constructed bridges of steel, concrete and masonry proved altogether too costly in many cases. Therefore, when the corrugated iron culvert made its appearance—first patented in 1896 by James H. Watson—highway engineers became interested.

The new culverts were first tried singly and in small diameters, and then in larger diameters, heavier gauge metal, and in batteries. However, even as far back as 1897 a few as large as 60 inches in diameter were installed to replace wooden bridges. The great strength of these culverts is adequately attested by the many installations that have been in service for years under deep fills on highways and transcontinental railroads.

The use of large diameter corrugated pipe for service as small bridges has increased steadily as the good roads movement has progressed and traffic demands have made the removal of existing structures necessary. It has been installed in diameters up to 108 inches, and the gauge of the metal has been increased until now 8 gauge material is often used

where service conditions promise to be severe, or an extra large diameter is desired.

The economy in the use of corrugated pipe for bridges is due not only to the lower cost of material, but also to lower cost of installation. Expensive equipment is not necessary, and no highly skilled labor is required. The following is the recommended procedure:

1. Prepare a firm even foundation,



Installing a 96-inch Armco ingot iron culvert under an old wooden bridge in Clarke County, Washington. The culvert was 36 feet long and installed in three sections of 12 feet each.



Above is shown two sections of Armco pipe 96 inches in diameter ready for installation under an old wooden bridge in Fulton County, Georgia.

free from stones and other obstructions, to give an even bearing surface. The grade should be from three per cent to five per cent.

2. Place the culvert, inside laps down stream, and make sure connecting band is firm.

3. Place earth around culvert, carefully tamping the back-fill. Alternate loads of earth, first on one side then the other, and distribute it along the culvert's entire length.

4. When the culvert is covered, the earth can be dumped with less care. It is well to continue a uniform distribution of earth to the finished grade, when it can be rolled or tamped compactly.

5. If headwalls are to be installed, it is best to wait a week or so, to allow for settlement.

The same procedure is recommended when large diameter pipe is installed in battery to care for flow in larger streams. In such installations, the pipe should be spaced $1\frac{1}{2}$ diameters on centers, and especial care should be taken to see that the earth is firmly tamped between them.

It is usually unnecessary to divert the flow of water in the stream, unless it is rather deep. Even when installing headwalls on the corrugated pipe a simple arrangement such as installing a smaller length of corrugated pipe inside the larger, and damming the flow into the smaller pipe with earth, usually serves to keep the footing of the headwall dry during the installation process.

Traffic detours are held to a minimum by installing one section of the pipe at a time. In cases where the pipe replaces an existing bridge, the latter is often left in place until the pipe is ready for the fill, after which it is only a short time until traffic can cross the culvert as the earth is placed. An added advantage of the culvert bridge is the level road surface. No grade to the approach is necessary. It forms an integral part of the road.

Though costs vary widely in different territories, a comparison of average costs shows that the corrugated culvert bridge installed costs approximately half that of other usual bridge structures. Freedom from repair and maintenance costs also adds to their economy.



This photograph was taken at 2 P. M. on the same day that the photograph shown at the top of the page was taken 7 hours earlier. This gives some idea of the ease and rapidity with which this installation was made.

Latin American Engineers Study Road Building in United States

"We see today, more clearly than ever before, that the improved means of communication is not only one of the great forces making for cultural and economic advance, but it is also one of the basic factors in the development of Pan-American Unity."

Calvin Coolidge.



Pan American Highway Commission being welcomed by Secretary of State Hughes at Washington, D. C.

THIRTY-SEVEN highway engineers and other delegates representing all Latin American Republics spent the first three weeks of June studying road building activities in the United States. They were heartily welcomed by President Coolidge, Secretary of State Hughes, Secretary of Interior Work, Secretary of Commerce Hoover, and many other prominent officials, including Secretary of Agriculture Wallace, who said, in part:

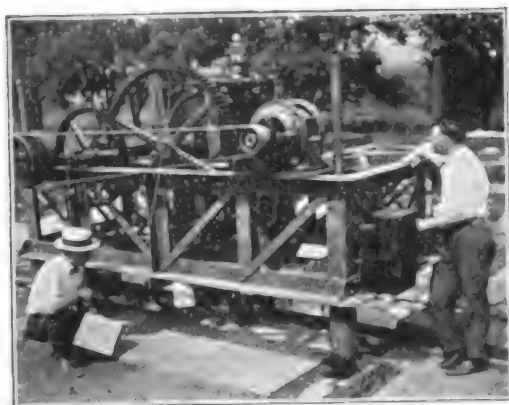
"I take it that we can serve you best by talking as little as possible and showing as much as possible of what we are doing. . . . Our objective, state and national, is to bring about as rapidly as we can, without overburdening our tax-paying public, a system of highways which will connect the main points, cities, in state and country, and to aid in that the Federal Government undertakes to contribute as much as one-half the cost of building these highways, which have been laid out with a view of ultimately making a connected system. We are spending now about seventy-five

million dollars a year of Federal funds in co-operation with the states."

Secretary Wallace also stated that according to his department's experience in road building, there were certain important features outside of engineering problems which must be considered, including the rainfall, the temperature, the character of material most readily available at a reasonable price, and above all, the use to which the roads are to be put.

On a trip to the experiment station of the U. S. Bureau of Public Roads at Arlington, Virginia, the delegates showed special interest in the demonstration on the impact forces brought to bear on modern highways by motor trucks. By means of recording apparatus attached to an army truck, the impact resulting from driving over small obstructions or irregularities in the road surface was accurately measured.

One of the interesting scientific developments shown was the fact that concrete pavements are constantly in motion as a result of atmospheric and temperature changes. This was brought out



Engineers checking results of the impact test on the specially designed machine at the Experiment Station at the U. S. Bureau of Public Roads, Arlington, Va.

by actual measurements. The delegates were shown how the heavy slabs of concrete curl up at the edges during the night, and down during the heat of the day. This warping in conjunction with the weight of the vehicles, it was explained, causes cracking of the pavement. New methods of designing pavements to prevent serious cracking were explained by the testing engineers. By an adoption of these methods the life of the pavement can be materially increased, while the cost of construction can be reduced by approximately \$1,500 a mile, a practical result from the experiment.

Engineers throughout the world have been interested in these experiments, and a majority of the delegates already were familiar with the more important contributions to the science of highway engineering resulting from them, but all were keenly interested in this first-hand study of the work of the Federal Bureau.

After a visit to the Bureau of Standards and various entertainments the party left for a week's inspection of road building projects in North Carolina, where highway conditions, climate and topography are held to be similar to those to be found in many of the Latin American republics. In this state and those of Kentucky, Illinois, Minnesota, Wisconsin, Ohio, Michigan, Pennsylvania, New York, New Jersey, the delegates had excellent opportunities to study methods and equipment used in the building of all types of roads in-

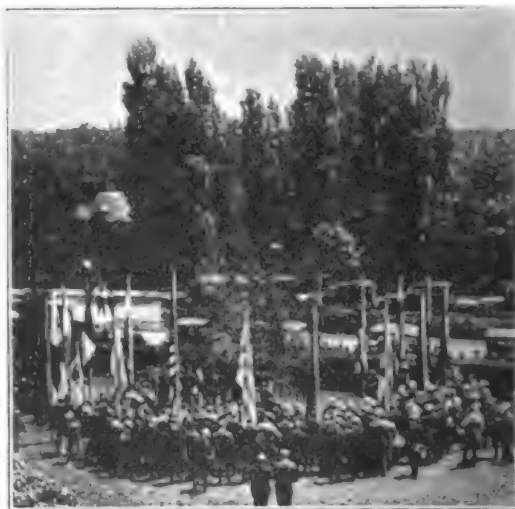
cluding dirt, gravel, asphalt, brick, macadam and their variations in the different stages of construction.

In Illinois, special attention was paid to the maintenance and oiling of black soil earth roads, the Bates Test Road, and methods of grading, while the object of the Minnesota tour was chiefly to study the roads through the sparsely settled country, including swampy territory, and the methods of building and maintaining gravel roads used in that state.

In Wisconsin methods of natural surface maintenance and the construction of the inexpensive types of roads were studied, as well as the equipment and operation of small gravel pits.

In fact, each state visited made some particular contribution to the highway construction and maintenance data gathered by the Latin American delegation, regarding whose visit Secretary Hughes said:

"I am certain that from the interchange of views and experience incident to your tour throughout the United States, conclusions beneficial to this country—and I hope to your respective countries—will be reached. You are performing a Pan-American service of magnitude and you may be assured of the enthusiastic co-operation of the Government as well as of the people of the United States."



A view of the ceremony during the planting of the commemorative tree at the Pan-American Union by the Pan-American Highway Commission delegates.

Building Highways From Waste Material

By OTTO V. MARTIN, Construction Engineer.



A section of the shale road between Ft. Smith and Jenny Lind, Arkansas, made from waste mine material described in the following article.

THE extensive scale on which road building is being done in some of the less populous states of this country is a fine tribute to the foresight and progressive spirit of their people. Arkansas, for instance, is now building a network of good hard roads that is rapidly bringing that state to the front in modern highway construction. In doing this, much plain "common sense" has been coupled with engineering skill, with the result that a great many miles of good roads have been built from the rather limited funds available.

An excellent example of this is shown in Sebastian County, where the road builders found within their own boundaries, ready for use, material sufficient for miles and miles of hard-surfaced roads and, best of all, this material is to be had for the asking, contributed by coal companies that have great quantities of it lying useless.

This material is burned mine shale. It was originally rock and slate which has been separated from the coal. As refuse, it is piled in great mounds where spontaneous combustion and the presence of a great deal of sulphur start it slowly burning, leaving it partially disintegrated shale. The action of the elements further reduces the shale to fragments, and when used as a road covering, it soon becomes pulverized and sets into a compact surface, making a

most satisfactory road. Burned shale has been used locally for roads around mines in Western Arkansas for many years, and these roads have been found to need a minimum of maintenance.

The first cross-country burned shale road is now nearing completion. It extends from Fort Smith through Jenny Lind, a small mining town, where great quantities of the burned shale are available, to Greenwood, a town about twenty miles away. The figures on the cost of the part completed and now open for traffic indicate that the average cost will be \$7,635 a mile. The most expensive stretch (three miles in length) cost an average of \$9,900 a mile. This extra expense was due to the necessity of constructing four turns twelve feet wider than the regular road, and to the fact that this stretch was furthest from the source of supply, resulting in added expense for hauling. The hauling is being done by 40 trucks carrying from $1\frac{1}{2}$ to 3 cubic yards at a load. A crew of twenty men work at the shale pile at the mine loading the trucks with slips when the steam shovel is down.

One of the most satisfactory features of this Sebastian County road project is that it is being built out of the regular county funds, without additional taxation and without issuing bonds. The contract between the county and the construction company doing the work,



The material used in the construction of this road is burned mine shale. The action of the elements reduces the shale to fragments and under traffic becomes pulverized and sets into a compact surface, making a most satisfactory road.

provides that the road shall be built in sections as ordered by the county judge or his representative. Standard specifications used by the State Highway Department are incorporated in the contract. The engineer in charge is paid a salary of \$250 a month, through the Secretary of the Road Commission, John M. Andrews, who receives no compensation for his services.

The following schedule of prices, embraced in the contract, may be of interest to those engaged in road-building projects elsewhere: Clearing and grubbing, \$140 an acre; earth excavation with one station (100 feet) free haul, 24 cents per cubic yard; embankments or fills with one station free haul, 24 cents per cubic yard; overhaul per station (100 feet) three cents per cubic yard; loose rock excavation per cubic yard, 80 cents; solid rock excavation, per cubic yard, \$2.80; loading, hauling, and placing burned mine shale, per cubic yard, haul up to 1 mile, 75 cents; 1 to 2 miles, \$1.05; 2 to 3 miles, \$1.30; 3 to 4 miles, \$1.60; 4 to 5 miles, \$1.90; 5 to 6 miles, \$2.35; 6 to 7 miles, \$2.75; 7 to 8 miles, \$3.15; 8 to 9 miles, \$3.55; 9 to 10 miles, \$4.00; 10 to 11 miles, \$4.40; 11 to 12 miles, \$4.85; 12 to 13 miles, \$5.25; 13 to 14 miles, \$5.70; 14 to 15 miles, \$6.10.

Other costs are as follows: Class A concrete, per cubic yard, \$14.00; Class B concrete, per cubic yard, \$13.00; Class C concrete, per cubic yard, \$11.00; deformed reinforcing steel, per pound, 4 cents; plain reinforcing steel, per pound, 4 cents; steel I beams for bridges, in

place, per pound, 5 cents; oak bridge flooring, in place, per thousand board feet, \$50.00; scarifying and reshaping old macadam road, \$250 per mile.

In order to maintain a maximum of comfort and safety on the state highways, Herbert R. Wilson, State Highway Commissioner, some time ago started a campaign which included the following objectives:

"Straightening the dangerous curves or placing guard rails or danger signs; elimination of the incompetent, reckless or intoxicated driver through forfeiture of chauffeur's licenses and prosecution of other offenders, and rigid enforcement of the traffic rules and regulations framed by the highway commission as 'Safety First' measures."

The improvement in Arkansas highways is bringing many people into the state, both as permanent citizens who will help to develop its natural resources, and as tourists who spend considerable money and also disseminate a wider knowledge of the state and its resources. Free parking grounds and campsites are provided for the latter class.

•••••

He Knew

A man who had just started to drive a car was accosted by a friend who asked him for a lift. They soon found themselves in a crowded thoroughfare.

The friend said, "Jim, your engine is knocking badly."

"Don't be a fool," was the reply. "That's my knees."

A Complete Road-Mender Truck

By CHARLES W. GEIGER,
Special Correspondent for The Highway Magazine.

Kern County, California, has placed in operation a complete road-mending outfit containing a wealth of equipment and operated as a single unit.

THE adoption of the motor truck to special uses has reached a high point in the vehicle shown in the accompanying photographs. This truck is in operation on road district No. 4, Kern County, California.

The truck carries a twin cylinder air compressor operated by a belt from the forward drive shaft; a rotary concrete mixer, driven by an auxiliary shaft from the transmission; a 150 gallon steel water tank, located just back of the material bins; a tar or road oil heating tank with a capacity of 50 gallons and heated by a gasoline burner arranged under the tank; a large pneumatic jack hammer, with assorted chisels, tampers, etc., a pneumatic post hole digger, for use in erecting fences along the highway; and an extension side arm or beam from the front of the truck for grading.

The water tank can be filled by means of a centrifugal pump provided with a self priming device and a suction hose.

In addition to the above equipment, the truck has combination material bins,



The complete road mending truck used in Kern County, California, showing air compressor, material bins, water tank and tar heating tank.

with capacities of 1000 lbs. of cement, 1 cubic yard of sand and 2 cubic yards of gravel or rock. Gravity feed from all the bins is controlled by hand operated gates to the mixing apron. There is also a draw bar attachment on the rear of the truck for hauling trailers or for operating the grading plow, and a syphon nozzle for spraying hot tar or oil.

The truck also carries a complete paint spray outfit, with hose and con-



Another view of the complete road mending truck showing all the equipment in place and the truck ready to travel.



The compressed air drill used in digging post holes for guard fence along the highway.

nections and steel stencils for lettering highways.

Other equipment carried is as follows: Steel wheel-barrow, one ten-ton jack and bracket for same, 200 feet of one-inch Manila rope, 25 feet of tow chain, hand tools including 3 shovels, 3 picks, 1 large sledge, 2 crowbars, etc., ten red lanterns, 10 "At Work" signs, 10 red flags, an oak platform and low stake body with special tool boxes.

The above equipment is designed to fulfill every need in road construction and repair work economically and efficiently as follows:

Repairing ruptures or breaks in reinforced concrete or plain concrete, macadam or other types of streets, highways or roads.

Using pneumatic jack hammers to break up the damaged places, pneumatic air jet to blow out refuse, materials from material bins, mixing same in power driven concrete mixer and spreading tar or surface oil over new work.

Erecting fences along highways or erecting county or traffic signs.

Using pneumatic posthole digger, materials and concrete mixer to set in concrete, tamping tool, paint spray outfit for painting or fireproofing. Side arm can be used for stretching wire.

Erecting or repairing bridges and culverts.

Using drawbar attachment to haul materials on trailers, oxy-acetylene welding outfit for steel repairs. Removing oil paint, rust, etc., from steel work with sand blast outfit and repainting with paint spray equipment. Heating and

driving rivets with rivet heater and pneumatic guns.

Leveling, grading, shouldering up, rolling or draining right of way along highways can be done by use of the grading plow attached to the extension side arm, also using the grader and steel roller tire on rear wheel.

Stenciling traffic or ordinance signs on streets or highways, using the special steel stencils made for the purpose, with the paint spray outfit.

Chipping out cracks on concrete highways with chipping gun and sealing the openings with hot tar through pressure nozzle.

Cutting asphalt paving with pneumatic chisels or jack hammer when excavating for sewer pipes, underground conduits, culverts, etc. Excavations can be properly tamped by tools provided and surface of street covered with asphaltum and rolled. Tar tank can be used to keep asphaltum hot.

Spraying trees and shrubbery in parks, streets and along highways, using water tank filled with fungicide and high pressure fog guns with air hose.

Putting out fires along highways, especially grain fires, which burn down fencing, using tank filled with chemical and high pressure through special nozzle. Speed of this unit in overgear makes it as practical as an auxiliary fire-fighting apparatus.

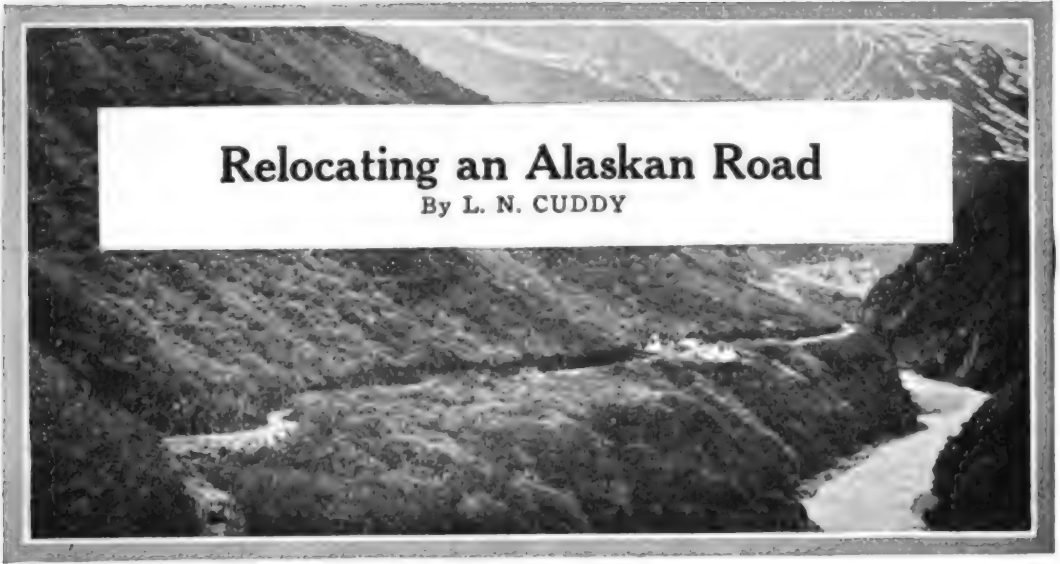
Suction hose and centrifugal pump can be used to good advantage in pumping out caissons in sewer or bridge construction, relieving flooded highways and for other uses.



Stenciling traffic and ordinance signs on the highway using the special steel stencils and the paint spraying outfit.

Relocating an Alaskan Road

By L. N. CUDDY



A portion of the new trail relocated above Keystone Canyon. Parts of the old trail now practically submerged, may be seen along the river below.

THE Valdez-Fairbanks Trail, in Alaska, is primarily a wagon road built by the Government from Valdez, a coast town, to Fairbanks, 400 miles inland. Along the Valdez end of the trail, known as the Keystone Canyon Road, some of the most wonderful scenery of Alaska is found, and especially noted is the Keystone Canyon, which is about three miles long and thirteen miles from Valdez.

When the Keystone Canyon Road was first built a narrow shelf-like passageway was blasted through the side of the canyon following the course of Lowe River, the stream which in the course of time has carved out the canyon. In maintaining this part of the road the Alaska Road Commission found a real problem. During the long, warm, sunshiny days when the road was most needed for transportation—not only for supplies to the interior but for the tourists from the States—the officers in charge often found traffic closed by the overflowing of the Lowe River due to the melting snows from the mountains and the swift glacier streams. When the waters subsided often the narrow shelf-like road would be so eaten out by the river that new blasting was required to make the road safe for travel.

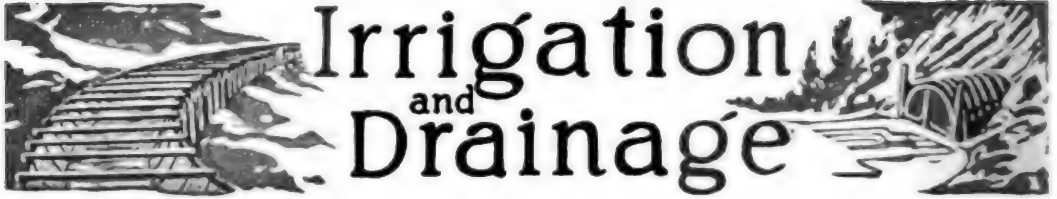
Two other natural difficulties had to

be overcome in order to keep the Keystone Canyon portion of the Valdez-Fairbanks trail open. Great rock slides were always to be expected, and every spring the far end of the canyon was completely blocked by huge snow slides.

The summer of 1919 was unusually warm, and before the season closed Lowe River had so completely wrecked this part of the trail that the Alaska Road Commission decided to abandon this most troublesome and expensive part of the trail and to relocate it.

In 1920 the work of building the new road was begun. Because of the glacier streams from the Valdez glacier it was necessary to provide a higher line from Mile 5 to Mile 22. The heaviest grading was from Mile 14 to Mile 16 along the Keystone Canyon Route. At the latter place a considerable part of the road had to be cut through solid rock. For this a portable compressor with three jack hammers and a crew of thirty to forty men were used the entire season. From Mile 1 to Mile 4 much bridging was done to fight the glacier streams. The road everywhere was thrown away from Lowe River, high above the flood stages, at a cost of \$105,063.66. It is now not only much safer, and cheaper to maintain, but the scenery to be viewed from it is even more delightful.

Irrigation and Drainage



Metal Flume Replaces Wooden Structure on Kiona Irrigation Project

How nearly 4,000 feet of flume were transported in a unique manner and erected in Benton County, Washington, is described in the following article.

THE Committee of Special Advisers on Reclamation in its report to the Secretary of the Interior points out that under the most extensive system of water storage and the most careful use of water, only a small portion, perhaps less than one-fifth of the arid region, may be brought under irrigation. Says the report:

"The wise and economical use of water must be the main concern of all interested in the development of the projects, as well as in the development of the arid and semi-arid area of the country. In fact, it is not the quantity of water secured by irrigation structures that determine the area of irrigated land, but rather the manner in which the available water is used."

The report further states that:

"Under the most favorable conditions the irrigation farmer carries a burden



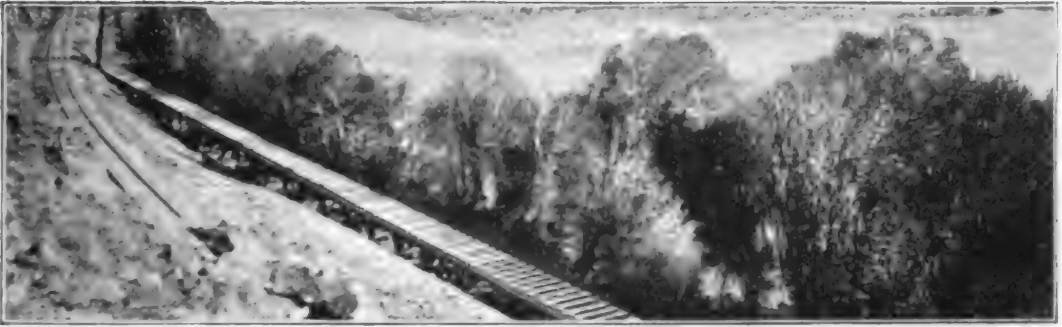
A partial view of the substructure of the flume on the Kiona Irrigation Project near Benton City, Benton County, Washington.

above that of farmers in humid districts" and also that:

"The true measure of the proper use



The completed flume on the Kiona Irrigation Project. This structure, made of Armco ingot iron, is 3,567 feet long.



Another view of the flume on the Kiona Irrigation Project paralleling the railroad and following the course of the Yakima River.

of irrigation water is the water cost of the crop produced."

It is this necessity for keeping water costs to a minimum that is forcing the discontinuance of the use of the wooden flume in irrigation projects, for the wooden flume is fast going the way of the wooden ship, the wooden railway car, and a great many other things once made almost entirely of wood.

The lumber warps, causing the flume to become leaky; and everything considered, it is too expensive as a water carrier on irrigation projects. Many of them are now being replaced with those made of iron. An interesting replacement of this kind was made a short time ago on the Kiona Irrigation Project near Benton City in Benton County, Washington.

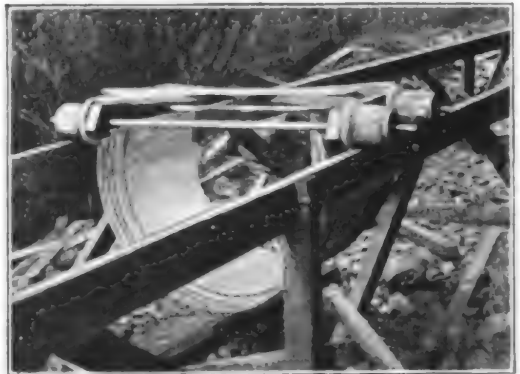
The flume, which is 3,567 feet long, follows the course of the Yakima River and parallels the Oregon-Washington Railroad and Navigation Company's tracks, which fact was taken advantage of by the constructors of the new flume. It enabled them to drop the supporting timber for the flume along the way at just the required intervals, thus avoiding much extra carrying which would otherwise have been necessary, because the narrow space between the railroad tracks and the flume prevented the use of teams or trucks. The same thing was done with the bands. This, however, could not be done with the sheets, which were divided into two lots and left near the ends of the flume. Special carriers were then constructed, as shown in an accompanying illustration, which traveled on the flume framework. They carried six to ten sheets at a time, and were easily rolled to wherever the sheets

were to be used, again avoiding carrying, and damage to the sheets.

Timbers set in concrete support the new structure, which is a No. 120, 20-gauge rust-resisting Armco ingot iron flume manufactured by the Coast Culvert & Flume Company.

As the flume was installed it was given a coat of paint, the paint being poured down into the flume and then distributed over the surface with big whitewash brushes equipped with long handles. By this method five men were able to paint the whole flume in one and one-half days, covering the 35,670 square feet of surface by applying 175 gallons of paint slightly thinned out with gasoline in that length of time.

The long life of this type of flume, together with its moderate first cost—the flume described cost a trifle over \$13,000 installed—and the fact that water leakage is avoided make this a highly economical installation.



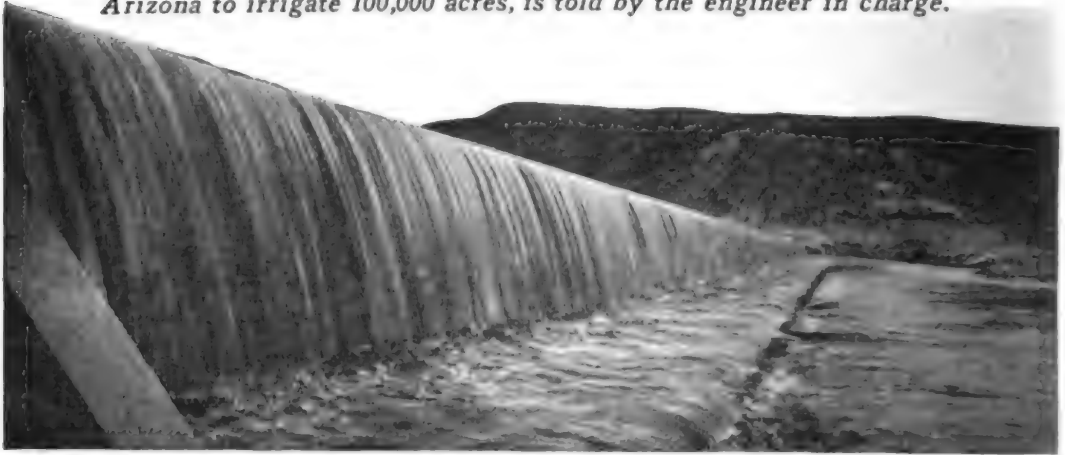
The special carrier using the partially completed substructure of the flume as a track, carrying the sheets to the point of installation, as described above.

Irrigating Arid Land With "Underflow" Water

By JAMES B. GIRARD

Consulting Engineer, Mem. Am. Soc. C. E.

How Gillespie Dam, begun more than thirty years ago as a loose-rock timber-cribbed structure, was finally completed as a modern multiple arch dam storing the underflow water of Gila River in Arizona to irrigate 100,000 acres, is told by the engineer in charge.



The Gillespie Dam across the Gila River in Arizona, with the river in flood stage.

DAMS have been built since time memorial; in fact, there are some standing today which were built in the time of the Ptolemys. However, the greatest progress in the building of these structures has been made in the last two decades. The last twenty years has witnessed the construction of numerous dams throughout the United States, particularly in the irrigation projects of the West.

Some time ago a dam was finished on the Gila River some sixty miles west of the city of Phoenix which is one of the most important of the great reclamation projects within the state of Arizona. It is known as the Gillespie Dam.

A former governor, Lewis T. Wolfley, conceived the Gila Water Company project. That was in the days before modern machinery and methods could be employed on dam construction, and it was attempted to build a loose rock, timber-cribbed dam, which would have been a successful structure if they had provided adequate spillway and apron. More than a million and a half dollars were expended in the construction of this dam and the building of the canal, and some three years of time was con-

sumed. It was finally completed and put into operation on June 30, 1894. The canal was some 40 miles in length and had a carrying capacity of 750 second feet at the headgates. The canal was constantly operated, and ran full of water to its entire capacity until the 25th of January, 1895, when the flood waters of the Gila River took out 60 feet of the dam, leaving the canal high and dry.

Pending the reconstruction of the dam and canal, the property became involved in litigation continuously from 1893 to 1909, when a United States Supreme Court decision was finally rendered.

Immediately thereafter work was begun in making soundings, borings, plans and estimates for the construction of a dam to bedrock, which in no place was more than 50 feet from the river bottom. Plans were made for a multiple arch dam to replace the old rock filled, timber-cribbed dam built by the pioneers.

Contracts were let for the construction of a multiple arch dam as designed by the writer. Coincident with the building of the dam, the canal was reconstructed. Immense siphons, conduits,



Another view of the Gillespie Dam on the Gila River, showing the secondary weir.

culverts and under-crossings of reinforced concrete were installed until today in its completed condition it represents the latest type of engineering practice.

Many engineers felt that a diversion dam at this point would not furnish very much additional water from the underflow, but the writer, having had experience in the building of structures on this river, as well as others in Arizona, and having encountered the vast underflow in the stream beds, realized that there must be a volume of underflow here or else it had found egress through some other channel. He therefore recommended the construction of a bedrock structure that would cut off the underflow.

The dam was completed during a period of extreme drought. At no time for thirty years had it been as dry; in fact, for the entire period of one year preceding the completion of the dam no water at all came down the Gila River,

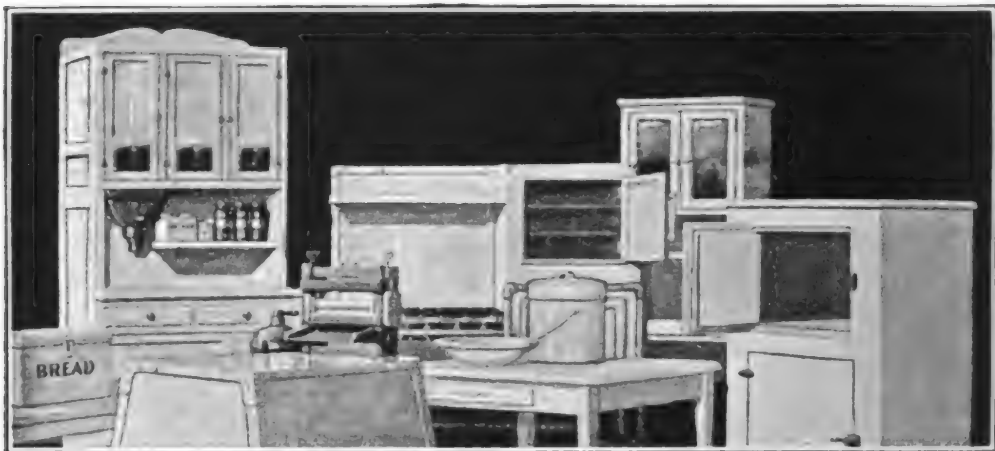
and not one-half day was lost in construction operations. Immediately on completion of the cut-off wall to bedrock a great volume of underflow was forced to the surface. The dam is one of the longest in the world, being some 1,800 feet in length and is, above the deepest bedrock, about 50 feet. The reservoir created by the construction of this dam contains some 15,000 acre feet above the ground. A great volume of water was used in wetting the sands and gravel beds back of the dam. It was plainly observable that the underflow, notwithstanding the fact that it was filling all the voids of the sand and gravel beds, was steadily increasing.

Unfortunately for the observation of this phenomena, the dam was completed just a short time before the summer floods which had failed to arrive the previous summer, and before a complete observation could be made of the exact amount of ground water which had been raised before the dam was overtopped. However, the volume of water brought to the surface gave ample evidence of a sufficiency to justify the conclusions of the engineers who had reported favorably thereon. These engineers, besides the writer, included men of such professional eminence as Mr. J. B. Lippincott and others.

This dam, which cost \$1,600,000, is also an important link in the Transcontinental Highway, for the apron, which is just below the secondary weir, is used as a bridge across the Gila River. It is, however, impassable in flood time. The dam as originally designed provided for a bridge at the crest, but this was abandoned due to the failure on the part of the federal and state authorities to reach an agreement.



A battery of ten 36-inch Calco slide headgates attached to Armco corrugated pipe in use on the Gillespie Dam project.



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October
1924

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The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XV

OCTOBER, 1924

No. 9



A captivating scenic turn on the Storm King Highway in New York State. Though only four miles long, this highway cost \$700,000, making it the most costly piece of road in the United States. Blasted out of the solid granite bank of the Hudson River, it presented great engineering difficulties.



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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Early Start on 1925 Road Show

THE 1925 Road Show and Convention of the American Road Builders' Association will be held at Chicago January 5 to 9, inclusive. C. M. Upham, business director of the Association, announces that much better arrangements have been made for both the show and convention than in any previous years. The preliminary plans also are already as far along as has been usual at a much later date. Every indication therefore is that these two big annual events in the road building industry will in every way eclipse all past records.

The program committee which will have charge of the convention will be headed by Prof. T. R. Agg. The organization of his committee is practically completed. Professor Agg has had such a variety of experience in the highway field that he will be able to produce a well balanced program of general interest. The convention sessions will be held at the Congress Hotel.

Nearly 17,000 square feet of additional floor space suitable for heavy exhibits will be provided at the Coliseum. This additional space is being obtained by the extension of the Coliseum to the north. The present main building and the adjoining building which have been used in the past also will be available.

There will thus be room for more and better exhibits than in the past.

Additional doors for bringing in the heavy exhibits also have been arranged. Plenty of time to get the exhibits into the buildings further will be allowed by the schedules made possible by the dates of the show. These improved arrangements coupled with the wonderful success of the last two road shows insure the largest and best industrial machinery exposition ever seen in this country.

Application blanks for space in the Road Show will be mailed shortly by Mr. Upham to all concerns whose names are available. Additional blanks may be obtained by addressing him at 37 West 39th Street, New York City.

Committees are being formed to handle the annual banquet, hotel arrangements, registration and various other features. The plans for these features, as well as for the show and convention, will all be arranged long in advance of what has been customary in previous years. With greater interest in highway building than ever before, the attendance from all parts of the country thus is certain to break the remarkable records of the last show and convention.

—HARRISON—

Yes, They Were "Agin" It

"THE noise of the railways would stop the hens from laying and prevent the cattle from grazing; that the poisoned smoke from the locomotive would kill the song birds and game, and that all houses anywhere near the railways would be set on fire by the engines." One hundred years ago the talkers were fighting the railroads. The above quotation is from a pamphlet published at that time. People must talk, but the big movement in transportation go on in accordance with the economic laws.

—HARRISON—

Why Not Now?

"Eventually," moaned the Sad-Faced Man after he had vainly driven around the square 18 times, "eventually the suburbs will come to be known as the place where a guy has to park his car while he transacts some business in the city."

The High Cost of Changing State Highway Personnel

An Exclusive Interview with THOMAS H. MacDONALD, Chief of the Bureau of Public Roads, U. S. Department of Agriculture.

By SPENCER HUFFMAN

Washington Correspondent for The Highway Magazine.

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Industry long ago learned that a large labor turnover is extremely expensive. Every effort has been made to keep it to a minimum. That it is just as costly and just as unwise to make frequent changes in the directing heads of state highway departments is herewith forcefully set forth by the chief of the U. S. Bureau of Roads.

"THE State Highway departments are just as much big business organizations as the

large department stores and as such should be managed on the same general lines, if efficient administration is to be had," Thomas H. MacDonald, chief of the Bureau of Public Roads of the U.S. Department of Agriculture, declared in an exclusive interview for *The Highway Magazine*.

"In the past two years many of the states have made changes in the directing personnel of their respective highway departments and the question has naturally arisen as to the loss and mistakes due to such changes.

"This constant turnover in highway departments is in my opinion a dangerous thing, and in the end will no doubt work to the detriment of the road construction programs in the states where such changes are too frequently made.

"The matter of turnover in highway departments is the same as the turnover in large business establishments. It is generally the case in the successful business house, that the management is

directed by one man or a group of men who have spent years in the firm and are acquainted with the well defined policies of the organization with which they are associated.

"This same system should be observed in the highway departments in the interest of economy and efficiency. It takes several years for a man to become acquainted with the state program and problems confronting him, and where a man has grown up with the service, in my opinion, it is decidedly unwise to make changes.

"It cannot be honestly said that a change in a highway department is necessarily a reflection on the engineer

when one man is 'stepped down' and a new man takes his position. These continual changes will only tend to hinder the production of results in road building, and may in many cases delay the work of the state for a considerable period."

One danger which may be encountered in too frequent turnover in directing heads is that of changes of policies which in the end will prove costly to



Thomas H. MacDonald, Chief of the Bureau of Public Roads.



Wisconsin's excellent, well marked highway system is the logical result of keeping a capable director on the job, A. R. Hirst having been chief engineer and executive officer of the State Highway Commission for 13 years.

the tax payers. For instance one engineer who steps into the position of the incumbent will decide that the program outlined involves too great an initial outlay of money and will substitute a cheaper form of road. At first glance it would appear that the state would save a great deal of money, but time and usage will demonstrate that the cheaper road instead of being economic will have cost a great deal more than the more expensive road originally planned.

"Another point that should be taken into consideration before making wholesale changes, is that of the program of maintenance. Take as an example two roads which were built nearby. One road was well maintained by the highway department of the state and the other road, which from a standpoint of apparent service was equal in value and construction, was not maintained as it had originally been planned by the designer of the road. The well maintained road has stood up and is in just as good condition today as it was when first opened for traffic. The other road has so deteriorated as to be in need of entire resurfacing. It can be seen that the economical road is the one on which funds were spent for maintenance, and the more costly road, the one which was built and then, so to speak, forgotten.

"In one instance the program of one engineer was sidetracked by that of a

new man. Maintenance was sidetracked and presently a corner break occurred. This road broke down at the rate of thirty-three feet a day under heavy traffic and was soon in such poor condition that a vast amount of money was found necessary to put it in first class condition.

"There can be no economy in endeavoring to save money at the expense of maintenance. Neither can there be economy where the turnover of directing heads of highway departments is great.

"Perfection in work can only be procured by continuous organization, and the policy of changing heads too frequently sets up a condition of uncertainty in highway departments which certainly is not conducive to efficient management."

Discussing the evils of the large percentage of turnover of directing heads in highway departments, Mr. MacDonald called attention to the recent statement of H. G. Shirley, chairman of the State Highway Commission of Virginia, in which it is pointed out that only harm can result from politics playing too large a part in the administration of road building programs of the states.

"Mr. Shirley states," said Mr. MacDonald, "that it takes from one to two years to become familiar with the conditions of the average highway system, and that it is a great waste when we see

at least twenty-three states changing their directing personnel.

"Failure of the public to realize the great importance of the rapid advancement of road administration, construction and maintenance has contributed largely to the present evil of too frequent changes. It is necessary for the highway engineer or administrative head to recognize changes in road building methods, and to direct and co-ordinate their work in order to meet them. In so doing they sometimes antagonize the leaders of the various parties and organizations who feel that the head of the department is going faster than the times justify and as a result a change is made.

"In this connection I might say that the engineer is in a better position to know the needs of his community than the layman. This is his business and the man in such work will generally endeavor to give the best to suit the needs of his locality and as economically as possible.

"Some criticism has been directed against engineers in the states on the ground that the 'ultimate' road has not been constructed. Here I might say that we do not know what the ultimate road will be, but must do the best we can to best serve conditions as they are, with, of course, a glance into the conditions which might arise in the future.

"By this I mean that where an engineer has a certain appropriation for road building he will generally study conditions and use that fund so as best to



A good stretch of highway near Lisbon, Ohio, built with the aid of federal highway funds.

meet the needs of the most people in his section. If the engineer starts building an expensive concrete road with funds that will carry it but a short distance, with an expensive but small addition each year, he soon meets with decided opposition.

"On the other hand, the man who takes this same appropriation and builds a length of road that will serve the greatest area, and, in building, plans for the future, is the man who is needed in his position; and it is decidedly unwise to make a change.

"My suggestion is that when the man is found who efficiently directs the work of his department, he should not be molested. Then the state will benefit not only from the possession of good roads but a saving in construction, which means a saving in taxes."



Brookland Park Boulevard, Richmond, Va., when it was still an unimproved country road, though connecting two high grade residential districts.



The same scene as that on the left, but after the laying of 60-foot, well-drained modern pavement which caused a remarkable increase in surrounding property values.

Rebuilding the Road to Almaden

In the beautiful Almaden Valley of Santa Clara County, California, is the mine from which the valley draws its name. Developed by Spanish-Mexicans and later taken over by Americans, whose claims were finally established by William the First, grandfather of the last German Kaiser, its history is interesting. With the recent renewed activity at the mine, which had been idle for about twenty years, came the rebuilding of the road through this scenic valley.

THE New Almaden Mine in Santa Clara County, California, was opened in 1823, and was named in honor of the mercury mine at Almaden in Spain, which was and is the largest in the world. The California mine was developed by Spanish-Mexicans, and operated with the crudest methods and equipment. After the American conquest of the territory, the mine came into possession of a New York company, but their titles were disputed. The emperor, William 1st, grandfather of the ex-Kaiser, finally awarded the mine to the American claimants on payment to the other heirs of a sum of \$1,500,000.

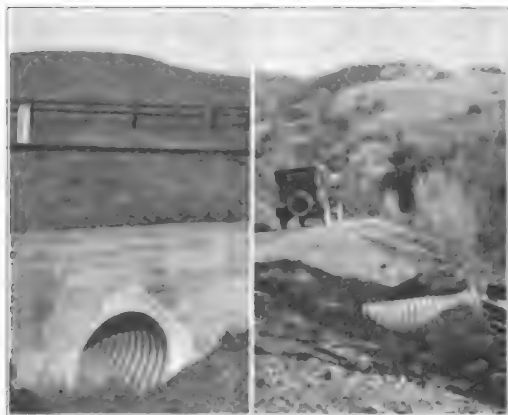
After this settlement the New York company was reorganized, and sent out as resident manager a very forceful character, J. B. Randol by name, who administered the property in the most able manner for nearly thirty years. This was the greatest period of the New Almaden Mine.

For many years its output was second only to that of its namesake in the old country. Then came about twenty years of inactivity due to the extremely low price of quicksilver. Recently operations have been resumed on a small scale.

One notable feature of Almaden in the days of its glory was the elaborate garden which surrounded the manager's residence. This contained great numbers of rare and beautiful plants from all parts of the world, and was one of the show places of central California. The center of the display was a wonderful pagoda which was the gift of the Emperor of China, and was said to have cost a hundred thousand dollars.

Winding through the beautiful Almaden Valley is a highway, known as the Almaden Road, below the mine, and the Alamitos Creek Road above. With the resumption of mining, this road was recently rebuilt and widened by the Santa Clara County forces. Large numbers of Armco culverts have been installed, some at new drainage ways and many others as extensions of Armco pipes which were placed nine or ten years ago. An important factor in the choice of drainage structures for the new work was the condition of the culverts of the same material which were installed under the Almaden Branch railroad line in 1908. These are all in practically perfect condition.

Mr. John Roll is Supervisor of the Road District and has had charge of the highway reconstruction. In point of service he is one of the oldest supervisors in the state. The Almaden Valley road runs through a highly interesting section of country and will doubtless in its improved condition, become a favorite drive for automobile tourists from all sections.



The Armco ingot iron culvert shown to the left was placed under the Almaden Branch Railroad in 1908, and was in such excellent condition when the road leading to the Almaden Mine was rebuilt recently the same type of culverts were installed as shown to the right.



Placing the rock for a sledged stone base highway.

Sledging Local Stone for State Highways

By B. H. PIEPMEIER,

Chief Engineer, Missouri State Highway Department.

Building excellent highways and doing so economically is the aim of the modern highway department. In the building of her modern highways, for instance, Missouri is utilizing local rock deposits wherever practicable. Where the local rock is not suitable for the surface course, it is used for making a sledged stone base, as described below by the Chief Engineer of the state highway department of that state.

IT has been the endeavor of the Missouri State Highway Department, insofar as practicable, to use local materials for the building of its state highways. This policy has led to the utilization of certain grades of stone that do not come up to the requirement for surface material but which can be used in large pieces for forming the base course for penetration macadam and asphaltic concrete surfaces.



H. A. Buehler, State Geologist, Member Ex-officio, Missouri State Highway Department.

The standard Missouri specifications provide that a sledged stone base, which consists of a foundation course of large stone, spalls, crushed stone and screenings, shall be bound together by the interlocking of the coarse parts by sledg-

ing and then by filling the voids with spalls, crushed stone and screenings, and finally rolling this layer so that it may serve as a base course for any type of filling surface that may be specified. This base, of course, must be constructed on a prepared subgrade. It is usually required that it shall be 8 inches thick after it has been rolled and thoroughly compacted.

The material used for such a base is a good or medium grade of limestone which does not contain an excess of shale, soapstone, or other material which will cause it to disintegrate. The stones may be as large as one man can readily handle. Spalls up to six inches in their greatest dimension are used; while the crushed stone is passed through a screen having circular openings three inches in diameter. A three-fourths inch circular screen is used for the screenings. The method of constructing this base is to spread the large sized stones uniformly upon the prepared subgrade, and then have the workmen go over the layer with sledges, breaking off corners until there shall be



Sledged stone base after rolling, ready to receive the surfacing.

no stones left larger than six inches near the top.

When the sledging has been finished, the surface is gone over and, where necessary, voids filled with spalls and crushed stone, so as to secure as nearly as possible a uniform distribution of the material. The surface is then rolled thoroughly with a 10-ton roller, after which any remaining surface voids are filled with spalls or crushed stone and then re-rolled.

In case any depressions or hollows develop during

this process of rolling, they are filled with stones of suitable size and with screenings and the layer is then again rolled until the course is thoroughly compacted and filled, and until the surface is uniform and smooth. In this manner, quarry rock that is too soft to provide suitable crushed stone can be readily utilized for a base course. Both limestone and sandstone have been used in this way for Missouri roads.

Although this type of base is comparatively new in its development, it seems to hold up very well. It is cheaper than other bases and permits the building of hard surfaced roads in localities where otherwise material would have to be shipped in. This base lends itself readily to the placing of any class of asphaltic surface.

The cost of maintaining roads over a sledged stone base has not yet been ascertained, because our experience does not extend over sufficient time to give a representative figure. It is believed, however, that for the average annual run of traffic over these roads they will show considerable economy.



Sledging off the high points.



A modern rural highway in Pennsylvania, which has greatly reduced the cost of marketing for farmers in this district.



The New Santa Fe Trail in Kansas

An Interview with O. M. WILHITE
President, The New Santa Fe Trail Association

By A. W. PEARSON

From an old ox trail to a modern concrete highway is the change being made in the Santa Fe Trail in Kansas. The result has been a great increase in value of adjoining land and the removal from the market of farms offered for sale before the improvement began.

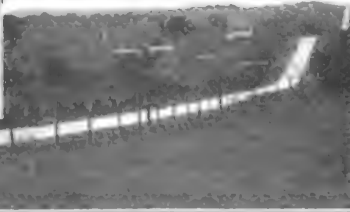
THE completion of the Lyon county sector of the New Santa Fe Trail, under the direction of W. S. Ruggles, county engineer, puts Lyon county in the class with 12 or 15 Kansas counties boasting cross-county hard-surfaced highways.

"The old Santa Fe Trail," said O. M. Wilhite, President of the New Santa Fe Trail Association, "was an ox trail, established as an outlet for the quantities of wool coming into Santa Fe from old Mexico. It was a trade proposition; bad roads and worse bridges, but the only route at that time. The new trail, from Kansas City to California, does not follow the line of that old oxen trail through the state of Kansas, because the people of this State are more practical than sentimental. It follows the shortest route, reaching the best towns through central Kansas, and making di-

rect connections with other routes. It passes the Harvey House system of hotels, and in general follows the main line of the Santa Fe railroad. Even the trail marker is built around the well-known emblem of that railroad."

The New Santa Fe Trail Association was organized in 1911, at a meeting of road boosters, in Hutchinson, Kansas. To date the Trail in Kansas alone has 212 miles of paved highway, with an almost equal number of miles in petition form. There are two connections between Kansas City and Emporia; the "capital city route," through Topeka, largely paved; and the regular line of the Trail, through Olathe and Ottawa, where a large amount of paving is already voted.

The Lyon county 20-mile stretch was paved in four sections. The first $4\frac{1}{2}$ miles was started on August 6, 1921. On June 6, 1922, the second four miles, west of Emporia, was begun. The $5\frac{3}{4}$ miles on the east sector was begun in Septem-



To the left is shown some of the modern road building equipment used in the construction of the new Santa Fe Trail, views of which are shown in the center and to the right.



Armco corrugated culvert with protecting head-wall draining a modern highway near Moberly, Missouri.

ber of the same year. The last six miles should have been completed in the fall of '23; but winter won the race, and the contractors could not lay the last mile until the spring of this year. On April 24, the road was finished, and the barriers went down opening it to travel May 23. The total cost for the 20.395 miles was \$745,812.95, or an average of \$36,568.42 per mile. A four-mile spur is now being laid toward Olpe, through a bad gumbo stretch.

The pavement, which is of concrete, is uniform throughout, being 18 feet wide, with center expansion joint filled with asphalt. A transverse expansion joint is placed on an average of every 200 feet. The slab is seven inches thick, both in the center and at the edges. The right of way is 66 feet on the west sector, and 60 feet east of Emporia. Dirt shoulders are five feet wide where the fills are not over four feet, but the specifications call for six foot shoulders and guard rails where the fills are over four feet.

It has not been necessary to remove surface soil, except for purposes of grading, nor has any substitution been made for the subgrade, except on the spur south of town, where a two-inch sand and screenings mixture has been laid for a foundation. No pipe under-drains are needed, as the moisture in the subgrade does not seem to be ex-

treme. Deep ditches seem to take adequate care of the drainage problem.

According to W. S. Ruggles, county engineer, the paving of this 20 miles presented no unusual engineering difficulties. Cutting down hills, spanning low spots, walling back the caving river bank, and eliminating dangerous double-S curves, is all in the day's work for the modern highway engineer. At one point a hard rain, following the pouring of the concrete, undermined about 200 feet of slab, which had to be relaid.

Much of the limestone used was native, and was prepared by a giant rock-crusher with a daily output of 100 yards. River sand and gravel from the local streams helped reduce expenses, as did the loan of a fleet of government trucks for which the county only paid freight.

"A back-to-the-soil movement is following this paving, such as follows every improved highway," said Mr. Wilhite. "And many farms have been actually taken off the market, which were for sale before instructions were



A view of the New Santa Fe Trail through rolling country near Emporia, Kansas.

given to go ahead with the survey and the plan profile.

"The rise in value of land fronting directly on the hard-surfaced road averages double the cost of the paving. That is to say, if the paving cost \$5.00 an acre, payable over a 20-year period, it is more than compensated by the increase in land value because of the paving, an increase that ranges all the way from \$10.00 to \$25.00 an acre. The average acre in the benefit district will only be taxed, as a matter of fact, after federal aid is received, something less than \$3.00 an acre."

Eight Wheel Motor Vehicles to Lessen Wear on Highways

By CHARLES W. GEIGER

Special Correspondent for The Highway Magazine.

Heavier and still heavier trucks and buses has been the constant tendency in the building of motor vehicles for commercial use on highways. The effect on the average road is to greatly shorten its life and increase its maintenance cost. Highway commissions have adopted various protective measures including weight per wheel limitations. But perhaps the real solution of the problem lies in the general use of eight-wheel vehicles as described below.

THE destruction of highway pavements by heavy motor drawn loads is the one subject of most serious consideration today among highway engineers.

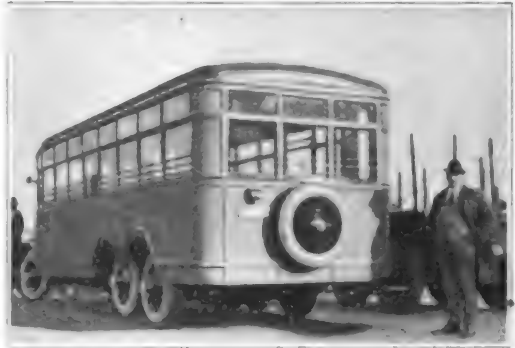
Up to the present time, bus transportation companies have had but little opposition to their use of public highways and city streets; but highway commissions are becoming more strict in their requirements as to weight-per-wheel.

This problem is more serious with trucks than with passenger carrying vehicles. Trucks, therefore, have ordinarily been equipped with solid tires; and although pneumatic tires have appeared in the last five or six years for trucks up to three or four ton capacity, their size and cost have prevented widespread use.

To solve the problem of excessive wear of highways by heavy vehicles, a California inventor perfected an eight-wheel vehicle whose weight per wheel when carrying 31 passengers is no greater than that of a heavy touring automobile carrying but seven people.

During the Pittsburg, California,

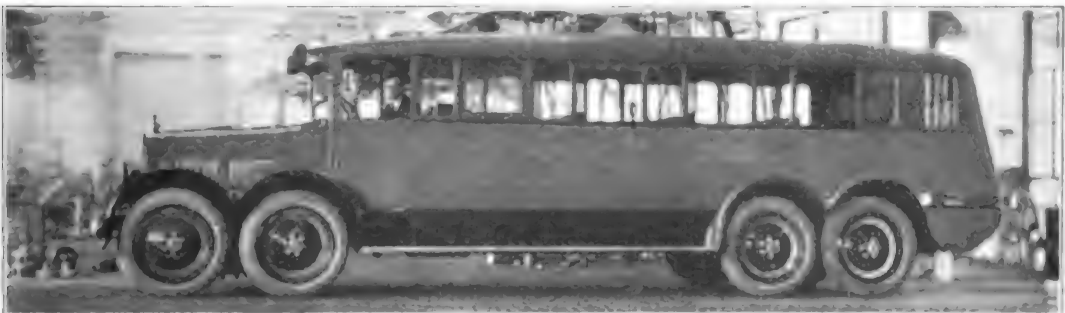
Highway Tests a comparison was made of the deflection of a four-wheel pneumatic tired truck and an eight-wheeled auto stage. The average of the values



Rear view of the eight wheel street car designed for use on highways.

for the moving load conditions showed that the four-wheel truck produced pavement deflections 50 per cent greater than the eight-wheel auto stage.

The inventor of the eight-wheel principle has built an eight-wheel motor bus, an eight-wheel street car and an eight-wheel motor truck.



Side view of eight wheel motor bus built by a California inventor to lessen the weight per wheel and thus overcome the destructive nature of modern heavy motor vehicles on highways.



Eight wheel motor truck so constructed that about fifty-five per cent of the load is carried by the rear wheels.

The bus is designed to carry twenty-four passengers in interurban stage service; the street car for thirty passengers; and the motor truck nine tons. The truck also tows a trailer or trailers carrying eleven tons.

The chassis of the eight-wheel vehicle is built with four front steering wheels, and four rear driving wheels, designed so as to give extreme flexibility in both the front and rear sets of wheels. The load is thus distributed over eight wheels, each wheel carrying half as much load as would be the case if there were only the usual four. Indeed this difference is even greater, from the fact that special attention was given to designing the eight-wheel trucks so that the center of gravity of the load is much

farther forward than on the ordinary four-wheeler. In the latter the two rear wheels usually carry about 85 per cent of the total load, while in the eight-wheel truck the four rear wheels carry only about 55 per cent and the four front wheels about 45 per cent of the load. Therefore, wheels and tires may be comparatively small, effecting economy and safety of operation. The center of gravity of the car being correspondingly low, these vehicles are less liable to slide off the road, or overturn on sharp curves taken at continuous speed.

The two front axles are connected by springs on either side, so arranged that the axles oscillate about a central trunion bar. If one tire blows out—indeed if a whole wheel comes off—the loss is so taken up by the inter-relation of the four wheels of the front set, that the steering ability is not materially affected. Since the load is so distributed normal tire pressures are sufficient for the eight-wheel vehicle, giving much greater resilience, as well as greater security against skidding and blowing out, than the higher pressure required on four-wheel heavy duty cars.

Experts who have seen the eight-wheel truck in operation claim that it has many advantages over the four-wheel truck for rapid transportation of large loads of perishable goods, such as fresh milk and ripe fruit. The extremely flexible axle hanging of both front and rear sets of wheels eliminates three-quarters of the road shock. The milk is not churned nor the fruit bruised.



View showing eight wheel truck crossing railroad track without jolting driver.

Hotels and Highways---Their Interrelation

By E. J. WILLIAMSON

More than \$250,000,000 went into hotel construction in 1923. Much of this unprecedented volume of hotel building was due to the enormous demand for accommodations from the motoring public. Hotel men, fully aware of this fact, are taking a very active part in the furtherance of good roads movements, as outlined in the following brief resume.

"GOOD Roads With Relation to Hotels" is a popular topic these days at hotel conventions. During the past year the subject has been discussed at practically every state hotel convention. The hotel men are interested in good roads for a very obvious reason. The roads, and the 15,000,000 automobiles that roll over them, have created a great deal of new hotel business—so much of it, in fact, that the hotel industry in this country is undergoing the greatest boom in its history. All records for construction of new hotels were broken in 1923. During the year more than 280 transient hotels of forty-room capacity, or larger, were built, the size running up to 1,200 rooms. The aggregate cost of these hotels was in excess of \$235,000,000 a figure which establishes a new high water mark for new hotel construction in any single year. Hotel men freely admit that the chief reason for this bumper crop of new hotels is the fact that, with 440,000 miles of smooth, surfaced roads to travel upon, the motor car owner is "hitting the trail" as never before.

The \$235,000,000 figure does not include hotels of smaller capacity than forty rooms. There were several hundred of these completed and opened during the year and their total cost is esti-

mated to have been \$25,000,000 or more, thus making a grand total of more than a quarter billion dollars' worth of new



The wayside inn has come into its own with the development of the automobile and the building of good roads.

hotels for the twelve-month. And there is already enough new hotel construction assured and actually under way to make it reasonably sure that 1924 will surpass the record of 1923.

Good roads are changing the hotel map



The log building to the right once housed the few people who came to use the waters of Hunter's Hot Springs, Montana. With the building of a modern highway, more people now visit the springs, and the log cabin has given way to the beautiful modern hotel shown at the left.



Hotels at one time depended almost entirely on the railroads and were located as conveniently to them as possible. In recent years, however, owing to the vast number of people who travel by automobile, many hotels have located near trunk highways.

of the country. Formerly the best and biggest hotels were in the large cities, which were almost always railroad centers. Now the cities like to be not only on the main trunk lines of the big railroads but also on the main trunk lines of motor travel, and it is the cities on these trunk highways that are doing most of the hotel construction. Railroad construction reached and passed its peak many years ago. Highway construction, according to present indications, has not yet reached its peak. In his recent report, Thomas H. MacDonald, chief of the United States Bureau of Public Roads, states that at the present rate of progress the 440,000 surfaced highway mileage of today will be doubled within the next ten years.

Garages operated in connection with hotels are no longer a rarity. The new 1,100-room Hotel Statler in Buffalo operates in connection with the hotel one of the largest, if not the largest, garage in that city, because so many patrons come in touring cars. A great many hotels have them and it is safe to say that half of the new hotels of 1924 will have them.

However, although the tendency is to build larger and larger hotels, even in the smaller cities, it is the hotel construction in the little towns and villages that indicates more strikingly the influence of good roads and touring cars. The wayside inn has staged a comeback.

The modern inn, of course, is different from its ancestor of stagecoach days. It has "all modern conveniences," and is at least semi-fireproof.

The hotel man is taking great interest in road improvement. Furthermore, he is taking an active part in promoting it. In New Jersey, for instance, the State Hotel Association headed by Frank C. Hall of Montclair, is one of the most active forces for the promotion of that state's \$40,000,000 road building program. Harvey M. Toy, of San Francisco, president of the California Hotel Association, is chairman of the California State Highway Commission and president of two tours associations. Edward M. Tierney, former president of the American Hotel Association, is president of the Empire Tours Association, and George D. Worthington, past president of the Pennsylvania Hotel Association, is also president of the Horse-shoe Trail Association, which is promoting a paved trail in the mountain country in the Altoona section of the Keystone State.

The big crop of new roads is begetting a big crop of new hotels, larger and better hotels, for those who travel over the new roads as fast as they are laid.



In order to appeal to the motoring public and serve its patronage, hotel owners have taken an active part in the promotion of highway construction and providing warning signs at dangerous points, as shown above.

Building a New Hampshire Highway

An Interview with ORRIN M. JAMES, Division Engineer,
By CHARLES H. CHESLEY

The construction of the Central Road from Concord to Dover in New Hampshire, which has provided an excellent highway for both tourist and local travel, has been made possible by the liberal appropriations of the towns through which it passes supplemented by federal and state aid. Costs have been kept to a minimum through the use of local materials wherever possible.

THE "Central Road," the diagonal line running from Concord to Dover, New Hampshire, a distance of 38 miles, is practically finished. This line extends through the towns of Pembroke, Chichester, Epsom, Northwood, Nottingham, Barrington and Madbury. Town, state and federal funds have been concentrated upon this road during the past five years. The last gaps to be finished were in the town of Epsom, Northwood and Barrington, and they were kept in good condition while the road was being completed.

Regarding the construction of the road, Orrin M. James, the engineer in charge, said:

"The highway is of gravel base, bituminous surface-treated. The average cost per mile has been about \$16,000. One mile near Spruce Cove, Northwood, however, cost \$21,000. This was due to the heavy fill across the meadow. A section in Barrington was underlaid with a rotten ledge, making that section run up in cost, but other sections cost considerably less than the average figures.

"The longest haul was three miles, as gravel of fair quality is found all along the line. Excellent banks in Barrington furnished gravel for the road below that section toward Dover, where the country is of a clayey texture. Most of the line has been constructed by the officials of the towns through which it extends. Town appropriations have been particularly generous and the road has furnished employment to a large number of men, who ordinarily might have been idle. Something like five miles have been built by contract, a good part of this section being in Barrington. Several sections in Northwood and Barrington were built last spring under the direction of town officials."

Concerning the cost of maintenance, once the line is complete, Mr. James

stated that this will depend largely upon the winter weather. "From \$100 to \$600 per mile," was his estimate for roads of this class. Lines subjected to heavy truck traffic may come up to the high figure, and this line will be used by freight trucks a great deal during the



An enchanting spot on a New Hampshire highway.

summer and fall. The past two winters snows have closed it to auto traffic for several months, and it is not likely that the diagonal lines of New Hampshire will be kept open for winter traffic until the Road Department finds itself in better financial shape.

In connection with the state road system of New Hampshire, it may be said that most of the building has been along the main lines of tourist travel. The State Grange and Farm Bureau federation have gone on record in favor of using more of the available funds for the construction of farmers' roads or sidelines. As the state is largely controlled by the representatives from rural sections, it seems likely that a larger proportion of the money for improved highways may be diverted to the sidelines.

Irrigation and Drainage



Construction Details of Tieton Dam

Thousands of acres now practically worthless for agricultural purposes will be added to the fertile fields of the Yakima valley on the completion of the Tieton Dam. The building of this dam, which is located in the Mount Rainier National Forest in Washington, involved a number of unusual features as herewith briefly described.

THE Tieton Dam when completed will create a reservoir having a capacity of 202,500 acre-feet, which will become a part of the storage

Tieton River at the mouth of the diversion tunnel and extending along the hillside for 2,200 feet, where a head of 78 feet is made available.

A diversion tunnel 2,200 feet long was excavated with a diameter of approximately 21 feet, which carries the waters of the Tieton River during the construction of the dam and will be used as a portion of the outlet control system when the dam is completed. This tunnel is through a solid cliff of andesite rock, which was drilled and shot by the top heading and bench method, the muck being loaded into 4-yard dump cars by a railroad type shovel with a short boom and A frame and equipped with 1-yard bucket.

The corewall consists of a concrete diaphragm completely crossing the



A section of the 72-inch electric arc welded pipe manufactured by the Coast Culvert & Flume Company of Portland, Oregon, for use as outlet pipe on the Tieton Dam project.

system for the Yakima project, Washington. It is located in the Mount Rainier National Forest on the Tieton River about 26 miles above Naches, Wash., the nearest railroad point. The dam is being built of earth heavily blanketed with rock, approximately 230 feet high and 900 feet long on the crest, with a concrete corewall of an approximate height of 330 feet extending from solid rock to the crest.

The equipment for a power plant of 1,000 K. W. capacity was purchased during 1918. This was installed and is now in operation. The water for the plant is obtained by a flume taking out of the



Above is shown part of the 1,200 feet of 72-inch electric arc welded pipe—one of the largest jobs of its kind in the world—to be used on the Tieton Dam.

canyon and tied well into bedrock on the base and sides. Below the ground surface it is 5 feet thick with no reinforcing. Above the ground surface it tapers to 1 foot thickness at the top of the dam, being heavily reinforced and without expansion joints.

In the river bed it was necessary to excavate to a depth of approximately 110 feet to secure the proper foundation. The excavation tapers on the east side of the canyon to 35 feet in depth, where-

Dam is the outlet pipe manufactured by the Coast Culvert & Flume Company, of Portland, Oregon. It consists of 1,200 feet of 72-inch diameter electric arc welded pipe made of $\frac{3}{8}$ -inch flanged quality steel. This is one of the largest, if not the largest, electric arc welded pipe job in the world.

It was made in 18-foot lengths, and has an absolutely smooth interior, which allows for a maximum carrying capacity with practically no friction loss. All



A general view taken during the early stages of the constructing of Tieton Dam, built to store water for irrigating thousands of additional acres in the Yakima Valley.

as on the west side of the canyon the bedrock is exposed and will require simply the cutting out of a key in the bedrock of about 5 feet in depth. This corewall is being excavated by a method known in mining as stoping.

The embankment, which will have a volume of nearly 2,000,000 cubic yards, is a hydraulic fill blanketed with rock. It has a maximum height of approximately 230 feet, a crest 900 feet long with a 3 to 1 slope on the upstream side, 25 feet top width, and a 2 to 1 slope on the downstream side.

A spillway will be built in the rock cliff on the west side of the canyon. It will have an overflow lip 420 feet long equipped with 6 drum gates of the Arrowrock type, 65 feet long and 8 feet high. The spillway will have a capacity, under normal conditions, of 30,000 second-feet with a capacity of 50,000 second-feet before the dam would be overtopped.

A noteworthy feature of the Tieton

field joints will be made by the electric arc welding process on the job. The pipe will be tested to 150 pounds static pressure, and while under pressure, all welded joints will be pounded with a 10-pound hammer.

During the process of the work eight separate tests of the shop welds were made in the presence of John Duthrie, government inspector, and the average efficiency of joints was over 100 per cent, using 55,000 pounds as the tensile strength of steel. The pipe has been spoken of very favorably by government and other engineers who have seen it.

In addition to the pipe, there are several 30-inch and 72-inch elbows, two 72-inch cast iron expansion joints allowing five inches expansion, cast steel flanges, steel nozzles, and manholes with covers.

It is estimated that the completed reservoir including the roads, right of way, and clearing, will cost approximately \$5,000,000 and will be completed in the fall of this year.



Field of cucumbers in Colorado being irrigated. Sugar beets and alfalfa appear in the background.

What Irrigation is Doing for the "Great American Desert"

By B. F. CLARK

Special Correspondent for The Highway Magazine.

Making two blades of grass grow where only one grew before is a figurative expression denoting a genuine economic contribution. In the Arkansas River valley irrigation has turned into the most fertile and productive of fields, vast areas of waste desert land that formerly had not even the single blade of grass.

THE Arkansas River Valley is one of the largest and richest west of the Mississippi River. There is perhaps no other valley in America where climatic and agricultural conditions are as varied. From Wichita, Kansas, west to Pueblo, Colorado, once known as the center of the "Great American Desert"; there is now an exceptionally fine section of agricultural country where crop failures are unknown. The farther up the valley and the farther into the semi-arid climate one gets the better are the crops and the

agricultural conditions as a whole. This is because the semi-arid district is more extensively and scientifically irrigated than are the regions farther east.

The rainfall in central Kansas is sufficient in some seasons to produce good crops, and these intermittent good crop years have had a tendency to hold back irrigation projects in this section. Western Kansas and eastern Colorado are quite arid. Consequently irrigation projects in these regions have developed rapidly, and more of the rich land lying farther away from the river is being reclaimed from year to year.

From Garden City, Kansas, to Pueblo, Colorado, is the famous sugar beet country. This country is also noted for the famous Rocky Ford cantaloupe and for alfalfa hay, wheat and corn. Other grains are extensively grown also. Small fruit, such as cherries and vegetables of all kinds do exceedingly well in this locality.

So extensively is this locality now being irrigated that the rolling country back on both sides of the valley, which a few years ago was barren, bleak and uninhabited, is now growing the finest alfalfa hay in America.

The writer's father took a homestead on one of these "bleak and barren hills"



A huge Armco ingot iron flume carrying water on an irrigation project in the West.

thirty-six years ago. He lived there but a few months, for there seemed to be nothing ahead but starvation. A few days before writing this article the writer drove over that old homestead and like the other farms all about it, it was covered with blooming alfalfa and the air was filled with an aroma akin to the scent of rich honey.

When the writer asked the farmer who now owns this old homestead what his land was now worth, he said, "Well, I don't care to sell; but if I did I could get three hundred dollars an acre for it."

The farmers living along this valley in the unirrigated district of central Kansas have just recently begun con-



A dam and canal used on an irrigation project in the Arkansas River Valley.



One of the largest irrigation canals in eastern Colorado.

templating an irrigation project for their part of the valley. But on account of the scarcity of water in the mid-summer season this project will have to be an unusual one. There is so much water now being used for irrigational purposes farther up the valley that the water supply during the summer season is insufficient in this locality.

However, the International Farm Congress is now contemplating a scheme which, when put into practice, will not only furnish plenty of water during the summer seasons but will reclaim a lot of rich overflow land as well.

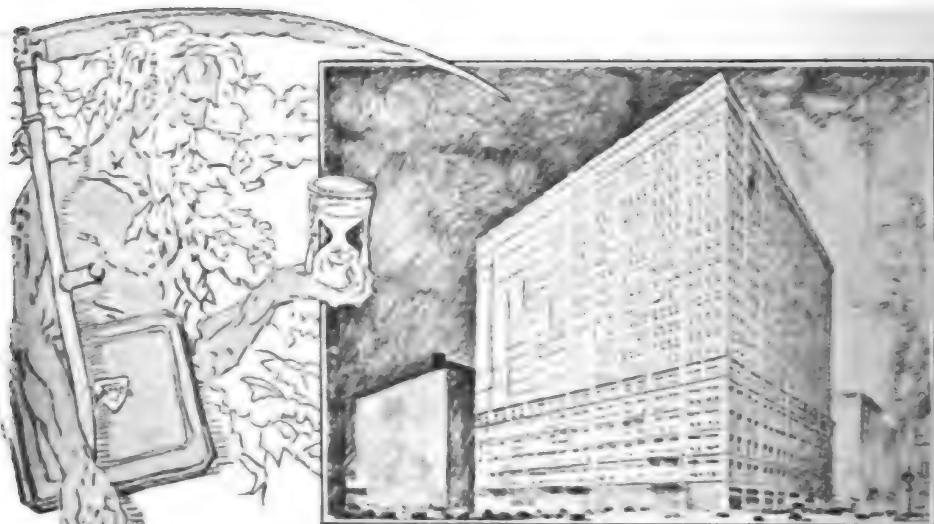
During the late spring months when the snow is melting in the mountains of Colorado, and the spring rains are falling farther east, the river often overflows in certain parts of Kansas, Oklahoma and Arkansas. Thousands of acres of crops are destroyed by these overflow waters every year.

The plan of the International Farm Congress is to conserve these flood waters and use them for irrigational purposes whenever needed. This is to be done by impounding the flood waters in great lakes, which are to be located above the level of the valley.

While this problem is a vast one, necessity demands it and the sentiment along the valley is in its favor. The problems of flood control, dry farming and irrigation are less troublesome when considered together. The majority in these localities have already learned this by experience and this great valley will some day produce three times as much as it does now.



A Calco automatic drainage gate attached to an Armco ingot iron culvert used on a large reclamation project.



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Window Frames Manufactured by J. F. Ruth, St. Louis, Mo.

Father Time Reports

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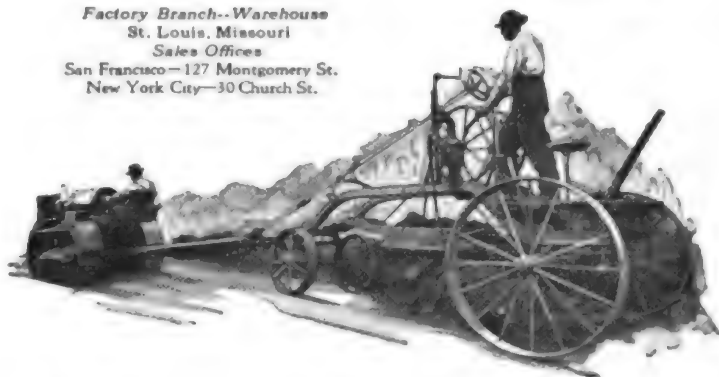
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The HIGHWAY MAGAZINE

THE JOURNAL OF THE

NOV 8 1924

UNIVERSITY OF ILLINOIS

**The Problem
of the
Scenic Highway**
(See Page 9)

November
1924



*Write to the nearest manufacturer
for particulars and prices on*
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California, Los Angeles
California Corrugated Culvert Co.

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The R. Hardesty Mfg. Co.

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Georgia, Atlanta
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The Burnham Mfg. Co.

Indiana, Crawfordsville
The W. Q. O'Neill Co.

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Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equip. Co.

Missouri, Moberly
Corrugated Culvert Co.

Montana, Missoula
The R. Hardesty Mfg. Co.

Nebraska, Wahoo
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North-East Metal Culvert Co.

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North Dakota, Wahpeton
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The American Rolling Mill Co.
The Ohio Corrugated Culvert Co.

Oklahoma, Oklahoma City
The Boardman Co.

Oregon, Portland
Coast Culvert & Flume Co.

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South Dakota, Sioux Falls
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Tennessee, Nashville
Tennessee Metal Culvert Co.

Texas, Dallas
Wyatt Metal & Boiler Works

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The HIGHWAY MAGAZINE

PUBLISHED MONTHLY IN THE INTEREST OF GOOD ROADS

VOL. XV.

DECEMBER, 1924

No. 11



HIGHWAY ODDITIES

The eight-steer team drawing a big log to the mill at St. Johns, Fla., recalls earlier scenes in America, when oxen played a prominent part in our lumbering operations.

The lower left hand picture shows Mr. and Mrs. J. S. Leddy of Goshen, Indiana, on their 10,000-mile trip about the country which was undertaken in order that Mr. Leddy might regain his health. The wheelbarrow carries their worldly belongings and serves as the "Pullman" for the two children.

To the right is shown the "cop" who directs traffic on the river in Bronx Park, New York, during hot weather when the lagoons and streams are literally swarming with boats.





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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Foresight Necessary in Highway Planning

AT a session of the Canadian Good Roads Association, William H. Connell, engineering executive of the Pennsylvania department of highways, brought out a most important point in the planning of our highways, declaring that organized and orderly control of highways is essential in order to prevent congestion in suburban districts becoming as bad as it now is in the larger cities.

"Lack of foresight on the part of the city planners in fixing street widths will necessitate the expenditure of great sums of money in widening those thoroughfares now built up with costly properties, which must be torn down to make provision for the traffic of today," said Mr. Connell; who added that, "the authorities in charge of highway work must make a comprehensive study of all the factors entering into and relating to a system of highway transportation in each specific territory under consideration."

On Mr. Connell's recommendation such a survey was conducted in Pennsylvania by the State Highway Department in co-operation with the United States Bureau of Public Roads, and the information gathered in this survey is now being used in formulating a plan

for the future highway activities of that state.

There are approximately 14,000 on the payrolls of the Pennsylvania State Highway Department. More than 12,000 of these are engaged in the upkeep work of the state highway system. Contractors engaged in new construction employ almost as many more, so that there is a total force of close to 28,000 working under the supervision of the State Highway Department.

It is estimated that the expenditures



Pike's Peak as seen from the Pike's Peak Ocean-to-Ocean Highway.

under the jurisdiction of the Pennsylvania State Highway Department from January 1, 1923, to January 1, 1927, will total \$220,000,000. During the same period the townships of the state will spend approximately \$85,000,000, which will also be under the general supervision of the department, though not so closely controlled as the other work.

In view of the gigantic proportions to which highway construction and maintenance have grown, the vast amount of money involved, the vital importance of highways to the development and general welfare of the whole country, and the ever-increasing cost of land for rights-of-way, it would seem indefensible to build or plan highways today without careful and serious consideration being given to the needs of tomorrow, even though some criticism may arise now from those short-sighted people who later will be loudest in their praise.

When to Pave Secondary Roads

An Exclusive Interview with THOMAS H. MacDONALD, Chief of the Bureau of Public Roads, U. S. Department of Agriculture.

By Gorman M. Hendricks
Washington Correspondent for The Highway Magazine.

To pave or not to pave secondary roads cannot be decided by a yes or no answer that will apply to all cases. The cost of construction and maintenance, the materials most readily available, and the amount of traffic to be carried, must determine the nature of the improvement.

THE much mooted question of paving secondary roads might be answered in this manner, that where traffic conditions warrant, secondary roads should most certainly be paved and surfaced, experiments in the past having demonstrated that the cost of paving will soon be paid for in money saved in transportation through improved hauling facilities.

The traffic counts made by the Bureau of Public Roads in Connecticut and Massachusetts in October, which is an average traffic month, show an average traffic passing each of four stations of 1,140 tons of commodities per day of nine hours. Adding one-third, as a very conservative estimate for the full day, we have a daily commodity movement of 1,520 gross tons, which includes the weight of the commodity and the carrying vehicle. From figures based on experiments conducted by the Iowa Experiment station, assuming gasoline

costs 24 cents a gallon, the cost of fuel alone for moving this tonnage over an ordinary dirt road would be \$26.44 per mile per day, assuming the impossible, that such traffic could be carried over a dirt road.

The cost of fuel for moving the same tonnage over a paved road would be \$11.70, a difference of \$14.74 per day. On the basis of 300 days per year, the actual saving in fuel alone for moving this tonnage would be \$4,422. Suppose the paved highway costs \$40,000 per mile. The average interest at 5 per cent would then be \$1,000 a year, which, deducted from the saving on fuel, would leave a balance that would retire the cost of the road in little over 11 years.

I do not mean to say that I favor the paving of all highways, even of the trunk line system. The type of improvement required is clearly dependent upon the traffic. If the traffic be known, the kind of surfacing or pavement to apply, or



Traffic as heavy as that shown in this view of the Boston Post Road warrants paving.

whether to apply any surfacing at all, is merely a matter of balancing the aggregate saving in cost of operation—which is a product of the number of vehicles and the reduction in operating cost made possible by the various types of surfaces—against the costs of the several types of improvements.

The following figures, determined in recent tests, give the tractive resistance of various types of road surfaces to ordinary farm wagons with equal loads.

<i>During spring wet weather</i>	<i>Tractive resistance</i>
Heavy soils unimproved	400-530 lbs. per ton
Gravel surface compacted	112-150 lbs. per ton

The same power will move four times the load on a gravel surface.

<i>During dry weather</i>	
Heavy soils, unimproved	186-215 lbs. per ton
Gravel surface compacted	50-75 lbs. per ton

The same power will move three times the load on a gravel surface.

Rolling resistance to motor truck with solid tires moving 10 m. p. h.:

	<i>Tractive resistance</i>
Earth roads well maintained	55 lbs. per ton



A secondary road in Tennessee before surfacing. It has since been paved resulting in a traffic increase more than paying for the improvement.

Gravel roads well maintained	45 lbs. per ton
Paved roads well maintained	35 lbs. per ton

It can readily be seen from these figures that poor roads are no economy and that as a matter of sound road economics even the secondary roads, should they serve a large number of vehicles, should be surfaced and, if the conditions warrant, paved.

OPERATING COSTS ON VARIOUS TYPES OF IMPROVED ROADS IN CENTS PER TON MILE FOR VEHICLES OF DIFFERENT TYPES AND SPEEDS

<i>Type of surface—</i>	<i>Autos, 25 to 35 miles per hr.</i>	<i>Solid tire trucks 10 miles per hr.</i>	<i>Pneumatic tire trucks 15 mi. hr.</i>
Average Portland cement, concrete and asphalt filled brick...	8.00	8.3	10.00
Best Portland cement and asphalt filled brick.....	7.75	7.70	9.3
Best gravel, yearly average.....	8.5	8.8	10.9
Ordinary gravel, yearly average.....	9.0	9.40	11.8
Waterbound macadam, well maintained.....	8.7	8.95	11.1
Bituminous macadam, well maintained.....	8.5	8.80	10.6
Average sheet asphalt, yearly average temperature.....	8.10	8.3	10.00
Average asphaltic concrete, yearly average temperature.....	8.00	8.3	10.00
Best earth, well packed by traffic, yearly average.....	9.0	9.40	11.70
Ordinary earth with light traffic, yearly average.....	9.5	9.95	12.60



To the left is shown a secondary dirt road before improvement; and to the right appears the same road after it had been given a gravel surfacing which increased traffic on it 300 per cent.



An excellent stretch of road in Texas west of Tyler. It is a federal aid project (No. 115) which has been given a gravel surfacing.

On the basis of these cost figures, a five-ton truck operating an average of 50 miles a day for 300 days—75,000 ton-miles per year—would save $1\frac{1}{2}$ cents per ton-mile—\$1,125 per year—if traveling over a good paved road instead of an ordinary earth road. Between the same earth road and an ordinary gravel road the saving on the operation of the truck would be \$375 per year.

In the final analysis, advisability of paving secondary roads must be left largely to the discretion of the community that is served by such a road. Where the traffic is heavy it would seem that the annual saving per ton mile would more than make up for the initial cost and the maintenance of the road. In other cases it is true that the saving would be so small when compared with the initial cost that paving would be

practical and economical in no sense of the word.

Fortunately we are not limited to any one type of improvement. Many primary roads in the country which are gravel surfaced are proving capable of handling traffic, as the cost of maintenance is small and the saving over the old dirt roads runs into thousands of dollars yearly.

In my opinion, no road should be improved to an extent in excess of its earning capacity; but all roads should be developed to the highest degree consistent with the return in the form of traffic economies. The primary problem confronting the engineer is to provide economical transportation, and in so doing it is necessary to resort to every material and every practice that can be utilized to obtain the end desired.



A secondary road which has been paved part of the way. The unimproved part of the old dirt road is shown in the background. Since being paved this road carried as much traffic as the average primary highway.

Developing an Economical Highway Patrol Maintenance System in Bourbon County, Kansas

By BLAIR BOYLE
County Engineer, Bourbon County, Kansas.

How Bourbon County built up in a few years an efficient and well equipped organization for building, patrolling and maintaining roads without increasing the tax rate, is described in the following article.

NOT so many years ago the average Kansas county shut down tight on road work at the first frost in the fall, dismissed all of the little organization it had, and did not start work again until pressure from citizens' delegations in the spring became too strong to withstand. This was considered the height of economy and worthy of commendation. The equipment consisted of a nondescript collection of slips; several light weight graders, usually in bad order by reason of having been left standing on the roadside without shelter during periods of inactivity; and drags of various weights, lengths, and construction, some of them home-made wooden contraptions.

Five years ago Bourbon County was a little ahead of the average county in the way of equipment, since in addition to the miscellaneous collection named above, it had a three-ton, a two-ton and a one and one-half ton truck. These were purchased by reason of the necessity for occasional resurfacing of the county's forty-five and one-half miles of water-bound macadam. It also had the nucleus for a shop and warehouse—a series of wooden sheds formerly used to house a contractor's equipment of teams and wagons.

The distribution of surplus equipment by the War Department, through the Federal Bureau of Public Roads and the State Highway Commission, to the



BLAIR BOYLE,
County Engineer,
Bourbon County, Kansas.

various counties at a nominal cost served to accelerate the development of an adequate system of road upkeep. It taught counties the economy of doing work with adequate equipment. Bourbon County has received a great deal of this equipment and purchased considerable not available from the Federal Government.

The 1919-20 winter was the first in which Bourbon County ever continued its construction and maintenance activities, but this has been done every winter since then. In addition to operators, superintendents and foremen for each kind of constructional undertaking, a trained personnel has been developed among the citizens of the county, as a considerable amount of constructional activity during the past four years has been carried on by day labor, hired directly by the county. Bourbon County now is in shape as regards equipment and trained employees to carry on two constructional jobs and the routine maintenance work at the same time.

The county also has a repair force which handles the upkeep of all equipment, a warehouse and purchasing organization which handles supplies and materials in carload lots, and a transportation system which functions smoothly



Equipment provided the highway patrolmen in Bourbon County, Kansas.



An Armco corrugated culvert under an improved highway in Bourbon County, Kansas.

in keeping scattered jobs supplied with men and material. It is worthy of remark that with this elaboration of organization, the various tax levies are as low, and in some instances lower, than those which prevailed during the period when operations were restricted to the summer and fall seasons.

On June 1, 1923, one more forward step was taken in the systematizing of highway maintenance. Bourbon County has a total of 196½ miles of county road to maintain, of which 93½ miles are paved and 103 miles are earth roads. This mileage was divided into eighteen patrol maintenance sections of approximately ten to twelve miles each. No attempt was made to confine an individual section to an all paved, or an all earth mileage, but rather the sections were laid out so as to have as many branches from a common center as possible, reducing the time of going and coming to various parts of the section by having a patrolman living near the logical center point of his section. It was considered that the right-of-way, back-slopes, ditches, and shoulder slope upkeep on a paved section would be approximately of the same extent as the upkeep of an equal distance of earth road. For the present, or until patrolmen may be properly trained, the upkeep of the pavement slab itself will be handled by a truck crew operating out of the warehouse as a center.

Patrolmen were hired under a contract for one year's service, and a bond of \$500 was required. A uniform rate of pay of \$100 per month for man, team, and wagon was established by the Board, and

very satisfactory men were secured at this rate.

Each man was supplied with a 1,150-pound grader, a steel beamed 150-pound plow and extra share, a number one slip scraper, two shovels, two picks, a scythe, an axe, and a pitchfork. It is contemplated that later a certain number of special type mowing machines will be provided which may be transferred from section to section. Drags collected from the dragmen of the old system were distributed to the patrolmen, but much of the work of shaping and smoothing the road surface formerly done with a drag now will be done by the patrolman with the blade grader.

In cases of special work requiring tools other than those assigned to the patrolmen, such as riprapping, and ditch deepening in rock, special tools may be assigned temporarily.

Since one of the advantages of the patrol system is that responsibility for the upkeep of a particular section of roadway is definitely fixed on one man, he should therefore be a resourceful man, one who can translate general instructions into action and fit conditions as they arise. He should be interested in and take pride in the successful upkeep and handling of his work. He should have had, if possible, some experience on road upkeep work. Preferably he should live near the center of his section. In choosing patrolmen these qualifications were kept in mind.



An Armco corrugated culvert with concrete headwall recently installed under a Bourbon County road.

It seemed advisable that compensation be on a monthly basis, on straight time, and for the entire yearly period. Winter months are usually either open and dry or with frequent changes between freezing, snow and thawing. In the latter case the daily maintenance will be of much value.

The county contemplates three types of signs in connection with the patrol maintenance system, although these have not as yet been installed. At the junction of two patrol sections, there will be a sign showing the numbers of the two sections, and the names and addresses of each patrolman. Small signs will be placed dividing each section into the work units or divisions. There will also be erected at each intersection of important roads a sign showing distance and directions to towns and cities.

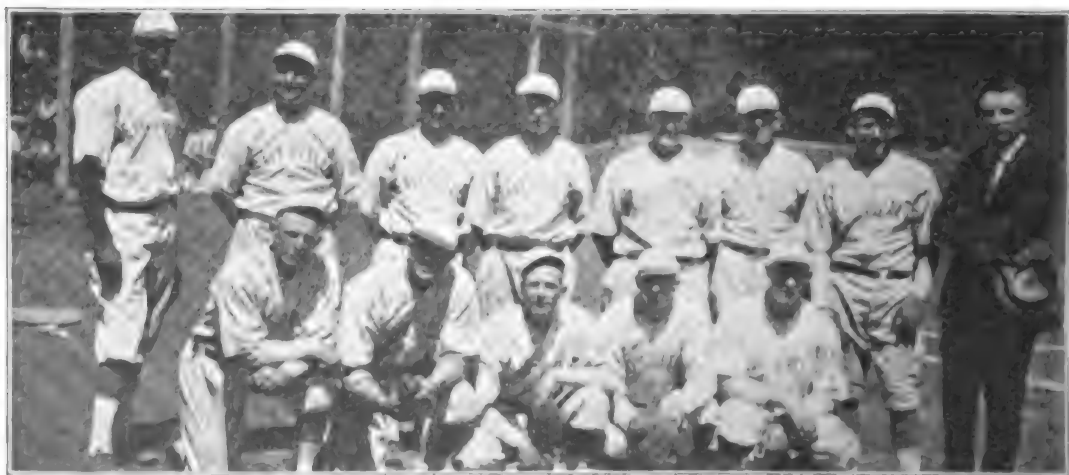
From past experience, it was decided to reduce the paper work required of a patrolman to an absolute minimum. We therefore designed a stamped post card daily report showing separation of the time for the day of each patrolman and such additional help as he has been authorized to employ under the following headings: cutting weeds or brush, repairing or placing culverts or bridges, surfacing earth roads with blade, plane or drag, grading with blade or slips, ditching and clearing waterways, shaping paved road shoulders, repairing pavements, snow removal, repairing

equipment and miscellaneous work.

As these cards come in daily to the County Engineer's office, they are posted on two forms. One form is the claim voucher which is later sent to the patrolman for his sworn signature, and which shows the hours worked by each patrolman, and extra help, from and including the twenty-first of one month to and including the twentieth of the succeeding month. These vouchers are mailed to the patrolman directly after the twentieth, and are returned properly signed in time for allowance at the regular meeting of the Board on the first Monday of the next month. The other form classifies the costs under the headings of the post card report, and from these are determined the distribution.

As the blade grader is the principal piece of equipment on a patrol section, considerable care was taken in the selection of this unit. The county officials finally decided to standardize on one make only so as to reduce the stock of spare parts necessary to keep on hand.

Our patrol sections are now equipped with patrol graders with two blades each, a seven-foot for smoothing surfaces and a five-foot for opening ditches and building shoulders. We feel that this weight of graders is about right, as we have been able to do very satisfactory work with one team as power, except in extra heavy ditching, in which case the grader is strong enough for two teams as power.



The Weaverville "Highways" baseball team of the California Highway Commission's Trinity camp. Several of the stars on the team are prisoners from the state penitentiary employed by the Commission as described on pages 9 and 10.

California Highway Commission Pays Convict Labor

Under a state law passed in 1923, the State Highway Commission of California has paid convicts a day rate for work on state roads; thereby greatly benefitting the prisoners, substantially reducing the cost of maintaining the state prisons without increasing the cost of highway construction.

CALIFORNIA is conducting one of the most interesting experiments in criminology in recent years—payment of a small wage to convicts from the state prisons employed in the construction of state highways.



Steam shovel at work on the new grade of the Merced-Yosemite Valley road.

While the employment of prison labor in state highway construction in California is not new, the granting of compensation is an authorization of the legislature of 1923. The present law has been in force since August, of last year, and is believed to be the first of its kind enacted in the United States.

Since the new pay law went into effect, some 850 men have gone through the three camps, now in operation, and have made net earnings of approximately \$34,000. Of this sum \$5,000 has been allotted to dependents.

This has been done without any extra cost to the state highway commission as the cost of operating the camps is no greater now than prior to the passage of the pay law, the money earned by the men representing economies effected in camp operation and management under the new plan.

The law provides that the commission

may pay the men a maximum of \$2.50 per day. Studies showed that it was costing the commission \$2.10 a day to keep the men at work under the former law and this figure was set as the wage to be paid.

Against this daily wage of \$2.10 the law directs the commission to charge the cost of transportation, meals, clothing, medical and dental care, camp management, guarding, payment of rewards, and the cost of small tools. When this has been deducted, the prisoner is permitted to retain a maximum of 75 cents per day, provided he can save that much. A review of camp reports indicates that many of the prisoners are making the maximum permissible under the law. In recent weeks, the average earning has been on the increase and is now around 50 cents a day.

Every man starts out obligated to the commission. Upon his arrival in camp, he is advanced an outfit of clothing, bedding, etc. This starts him off \$30 to \$40 in debt. If he is industrious, he gradually cuts down his indebtedness and begins to pile up a surplus which is his



Convicts of the Trinity road construction camp preparing a blast.

when he is discharged or paroled. Some of the men already have earnings of more than \$200 which will be theirs when they are released.

Under the old system, upon discharge, a man left the prison with a suit of clothing and \$5.

Many are taking advantage of the new pay law to have needed dental work done. Others are having their eyes tested and glasses fitted against the day when they will be free.

The prison road camps are honor camps in every sense of the word. The man in prison must make a voluntary application, backed by a good conduct record, to get a chance to go to the camps. When he gets there, every two days he works cuts an additional day from his sentence. Good conduct and willing work in the camps have great weight with the Board of Prison Directors in granting paroles.



In the center, Friend Wm. Richardson, Governor of California, inspecting the Briceburg prison camp accompanied by George A. Van Smith, President of the State Board of Prison Directors (at the governor's right); and U. A. Smith, sergeant of the guard.

A reward of \$200 is allowed by law for the capture of men escaping from the road camps and is prorated against the earnings of the men in the camp at the time of the escape. Few leave, however, although escape is not impossible under the conditions prevailing. Most of those who try to get away are soon caught and taken back to prison with all their earnings and credits lost. Once in awhile a man goes back voluntarily, but not often.

Under the law, all forfeitures go into the Prisoners' Fund for educational and recreational work in the road camps.



Convicts clearing away the rock after a blast on the new grade of the Merced-Yosemite Valley road.

The turnover in the camps averages about 8 per cent. This is one of the important factors in the success of the movement. A free labor camp in the remote mountain sections in which the prisoners' work probably would have a labor turnover of 40 to 50 per cent. Experience has shown that it is difficult to get free labor to remain for any length of time on these jobs.

The law provides that all skilled labor must be performed by free men and strict adherence to the law is the rule of the highway commission. Bridge builders, steam shovel operators, truck drivers and the like are free men in the prison road camps.

There can be no question of the value of the prison road camp from the standpoint of the prisoner. The man earns his way, builds up his self-respect and is discharged physically fit to face the world.

While it can not yet be claimed that the plan is reducing the cost of state highway work in California, it is bringing about a saving to the state in the cost of maintaining the state prisons.

When a man leaves for the road camp, the prison is immediately relieved of the expense of his confinement. Authority over the man, as regards discipline, remains with the prison, but the cost of his transportation to the camp, the salaries of the guards furnished by the prison, as well as all other expenses of the camps, are borne by the highway commission.

Lighting Our Highways at Night

By C. T. SCHAEFER, M. E.,
Member S. A. E. and A. S. M. E.

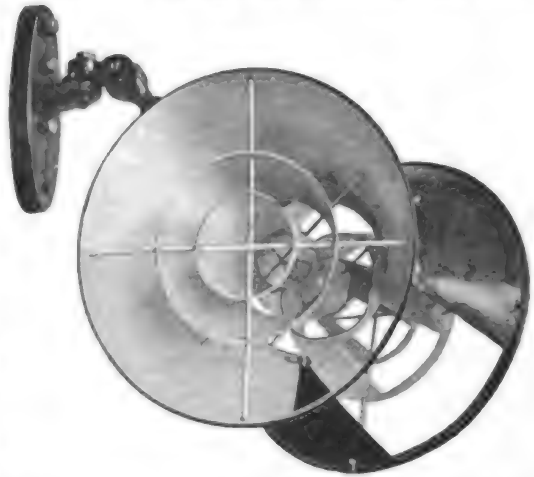
To make travel by night safer and more comfortable, new methods of illuminating highways, particularly in densely populated areas, have been developed and are being installed. By making headlights unnecessary they eliminate accidents due to their blinding glare, as described in the following article.

ONE need not travel far at night on a main highway to be impressed with the vast number of tourists on long distance trips, with the amount of freight that is being transported in heavy duty motor trucks, and the number of people that prefer the motor bus as a means of interurban transportation. Neither does one travel far before the sight of a road accident, or possibly a narrow escape from one, emphasizes the need of better highway illumination.

An analysis made by the chief lighting inspector of the Massachusetts Department of Public Works some time ago of several hundred motor vehicle accidents indicated that of 258 occurring at night, more than 20 per cent were due to lighting conditions. Two-thirds of the accidents were attributed to insufficient illumina-

tion, and about 6 per cent to headlight glare.

Whatever means is employed for providing proper illumination must be capable of being installed, operated and



maintained at a cost that is not burdensome. These conditions have been fulfilled by new lighting units developed by the General Electric Company and the Westinghouse Electric & Manufacturing Company. The unit manufactured by the former company is known as the "Novalux," and consists of a 250 watt mazda "C" lamp in the center of two sets of three parabolic reflectors, the



Above to the right is shown the Novalux highway lighting unit with universal bracket, and to the left it is shown mounted on a lighting pole along the Albany road near Schenectady, New York.

whole unit being mounted on a bracket attached to poles at the side of the road. The effect of this arrangement of the reflectors is to direct the light on the surface of the roadway without scattering it upward or out across the fields. Although the original unit is only about seventeen inches in diameter, the arrangement of the reflectors is such that the intensity of light is equal to that which would be given by a single reflector fifteen feet in diameter. It gives a maximum of 4,300 candle-power. The unit is supported by a universal bracket, which makes it possible to adjust the direction of the light either horizontally or vertically, thus providing for the illumination of curves and grades. It is mounted 30 feet above the roadway and at varying intervals of from 200 to 700 feet, according to kind of road and the amount of travel over it.

The Westinghouse highway lighting unit consists essentially of a porcelain housing which contains a series socket for a type "C" lamp, a reflector and a double set of reflecting prisms. This unit is arranged for suspension from a series of interchangeable fittings to be fastened to brackets, mast arms, or span wires, as mounting conditions require. The reflector is made of copper, highly polished and lacquered on the inside. Its shape is parabolic and so arranged with relation to the refractor prisms that all of the light is thrown in a direction parallel with the roadway. Most of the light is controlled by the upper parabolic reflector which redirects the



Reproduction of a picture taken at night on a highway near Tonawanda, New York, showing the effect of modern highway lighting units.

rays vertically downward upon the two sets of refracting prisms, and thence to the road surface in two directions only.

The "Novalux" unit was first tried out on Paradise road, at Swampscott, Mass., and proved a success. Then a stretch of the Albany-Schenectady main highway in New York State was equipped with it. This road is part of one of the greatest transcontinental traffic routes. It connects two large cities, carries an immense amount of travel, and is correspondingly congested. Driving conditions are made the worse at night by reason of the fact that an interurban trolley line connecting the two cities parallels the road, and the light from the headlights of the cars is blinding. Moreover, there is a large suburban population along its entire length. Accidents on it were numerous and serious.

The turning on of the new lights was instantly followed by the emphatic approval of motorists, suburbanites and civic officials. The illumination achieved the purpose sought. It was and is possible to drive in comfort and safety along the stretch thus lighted without the aid of the lamps of one's car. The light overcame the glare of the lamps of the approaching cars, and pedestrians were visible for a long distance. This method of lighting is a new development made possible by a scientific study of illumination.



Highway lighting units installed on the causeway between Miami Beach and the city of Miami, Florida.

Building Roads to Develop Alaska

By COLONEL JAMES GORDON STEESE, M. Am. Soc. C. E.
President and Chief Engineer, Alaska Road Commission, and Director of Public Works for the Territory.

Alaska is rich in natural resources, but needs roads to develop them. The roads are being built, but under great difficulties, as explained in the following article by the engineer directing their construction.

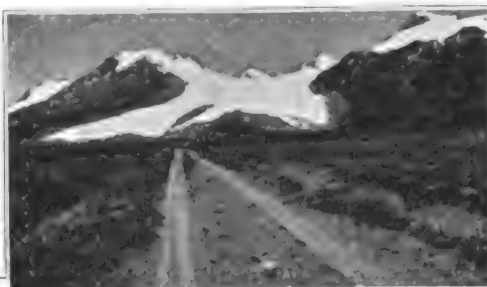
ALASKA is essentially a country of bold relief, with glaciers a conspicuous feature of the mountain systems. The streams created by the seasonal melting of the glaciers, are among the most annoying obstacles encountered in road construction.

Nearly everywhere, the ground is permanently frozen to within a foot or two of the surface. It is practically impossible to proceed with wheeled vehicles anywhere without some form of prepared wagon road. Except where the frozen surface of a river is used, it is necessary to clear a trail even for dog teams. Many streams remain open all winter and must be bridged.

In road construction, the cruising, clearing, grubbing, thawing out, grading and surfacing includes all work done upon the roads in settled parts of the United States from pioneer days. In Alaska, the ground must be thawed out and a drainage system created. The

need for some form of overland transportation is met first by the use of sled roads and trails. These provide a means of penetrating inaccessible country and of bringing it into a stage of development warranting the heavier cost of construction of a graded and surfaced wagon road.

When the right of way is first cleared and exposed to the sun's rays, the resultant thawing creates a veritable bog. A great deal of corduroy is necessary in the low spots. Innumerable box culverts of spruce logs must be placed as the entire adjacent country immediately drains into the deep and wide ditches necessary to dry out the subgrade. After several years, the water table is permanently lowered, the subgrade is thawed out deep enough to give stable support to the gravel surface and the box culverts have rotted out. Two-thirds of them may now be filled in and the other third replaced by corrugated metal culverts.



Above: Worthington Glacier, Alaska, seen from the Richardson Highway; at left below, building a bridge over the Nizina River, part of the work being done in a temperature of forty degrees below zero; to the right below is shown a load of Armco corrugated culverts in McKinley Park ready to be distributed to various Alaskan roads.



Alaska Road Commission map indicating in heavy black lines the railroads (furred edge) and highways used in making the Alaskan tour of 1923, and also showing important points described in the accompanying article.

Here the matter of supply becomes important. On the Richardson Highway, 320 miles from Chitina on the Copper River & Northwestern Railway to Fairbanks on The Alaska Railroad, metal culverts have now been distributed for 90 miles out of Fairbanks and 150 miles out of Chitina. On the Valdez end, they have been hauled from the coast over the Chugach Mountains through Thompson Pass at an elevation of 2,750 feet. Many hundreds more will be required to complete the job. In other parts of Alaska, they are hauled by dogs.

Some time ago The Alaska Railroad was completed to the Tanana River and connected up with the narrow gauge section centering on Fairbanks. Since then the narrow gauge has been standardized as far as Fairbanks. As a result, the transportation situation in the interior has been changed radically. Instead of an entire year's supplies being landed by boat during the short summer, with the attendant high costs for investment, insurance, storage, depreciation, etc., supplies are now landed twice a week all the year round to the entire railroad area.

The far interior still has to provide for itself for an entire year at a time, but such supply is now based upon the railroad area instead of a south coast port or Seattle. The Alaska Railroad, therefore, with its river boat service, and tributary highways and trails, is the backbone of Alaska's transportation system, which, by river, rail, highway, or trail, reaches to all inhabited districts.

During the opening of the new diggings in the Chisana region a few years ago, beans, coffee, sugar, hay, candles, bacon, grain, etc., were sold at \$1.50 a pound. The freight charges were almost a dollar a pound, so that the original cost of the article was of relatively little importance. And even at that, the supply could not keep pace with the demand. Last summer the freight charges for transporting supplies from Dawson, in the Klondike, to some mines about one hundred miles away in the American 40-Mile District, was greater than the original cost of the supplies plus the freight, from the United States to the



The two spans—one 100 feet and one 150 feet—of the Chatanika River Bridge which were taken down on the ice, freighted three miles on horse sleds, 265 miles over standard gauge, 90 miles over narrow gauge, and twelve miles by tractor drawn sleds, and then re-erected on the other side of the Alaskan Range.



Alaska Road Commission construction camp near Sourdough on the Richardson Highway showing the caterpillar drawn graders, gravel trailers, trucks, and gasoline drums. Gravel is handled by a gasoline driven dragline.

Klondike. (Dawson is 1,700 miles from Seattle.)

At Lisianski Inlet, in southeastern Alaska, in 1921, I observed lumber, pipe.



Hauling Armo Culverts by dogsled to the point of installation on the Talkeetna-Cache Creek road project.

tar paper, groceries, etc., being carried on the backs of Indians from the beach up a slippery mountain trail about 7,500 feet long to a new gold strike in a little basin at about 800 feet elevation at 4 cents per pound, or \$80 per ton—over one cent per ton-foot.

Railroad transportation cannot yet be regarded as a usual form for Alaska, and steamship rates are entirely arbitrary, depending upon competition. They, like the existing railroad rates, have been fixed by two factors only: 1st, the cost of hauling on some competing wagon road, sled road, or trail, where such competition exists (or, in the case of steamships, sometimes by competing steamer line); and 2nd, by the highest rate the freight can stand and be shipped at all.

The total mileage of roads and trails constructed or maintained by the Commission aggregate 9,624 $\frac{3}{4}$ miles, consisting of 1,497 $\frac{3}{4}$ miles of wagon road, 1,088 $\frac{1}{2}$ miles of sled road, 6,326 $\frac{1}{2}$ miles of permanent trail and 712 miles of temporary flagged trail.

During the past year the work may be summarized as follows: New construction, 34 $\frac{1}{2}$ miles wagon road, 96 $\frac{1}{2}$ miles of sled road, 280 miles trail, and 1,234 lineal feet of bridges of over 60 foot span; Improvement, 20 $\frac{1}{2}$ miles wagon road reconstructed, 53 $\frac{1}{4}$ miles wagon road graveled, 42 miles Nome-Shelton Tramway opened for traffic, and innumerable small bridges and culverts rebuilt; Maintenance, 1,151 miles wagon road, 661 miles sled road, 3,598 miles permanent trail, and 477 $\frac{1}{2}$ miles temporary flagged trail.



Armo corrugated iron culvert installed under a road in McKinley Park at a point known as Mile 1. This is but one of many similar installations made under the direction of the Alaska Road Commission.



Large Culverts Replace Bridges on Reclamation Project

By I. H. SMITH, Chief Engineer,
The Holland Land Company.

How the Holland Land Company of Clarksburg, California, floated large diameter corrugated iron culverts into position in water five feet deep and sank and back-filled them to replace bridges that failed under heavy truck traffic.

IN the past two years hauling of the great quantities of sugar beets grown on the Holland Land Company's tract at Clarksburg, California, has created a big problem in bridge maintenance in this tract. About 100,000 tons of these beets were moved this year. Yields as high as twenty-five tons per acre concentrate extraordinarily heavy tonnage into small areas. Some of the dumps handle 500 tons per day, the tonnage being limited only by the dump capacity. What happened to our bridge decking may readily be imagined. This traffic continues with varying intensity for about two and a half months.

At about the peak of the beet traffic, the beans come along. This year they aggregate about 5,000 tons. A few thousand tons of potatoes, onions, and barley add materially to the traffic, not to mention over 20,000 tons of alfalfa, which,

like the poor, is "always with us."

The truckmen want to carry all they can load, which is from six to twelve tons when the truck is included. They "open her up wide" on the roads and don't slow down for bridges, unless the deck gets a hole in it.

We have used Armco culverts for several years, and know they are "truck proof." So as our old bridges wear out, which they do quite often, we are replacing them with this type of culverts. Not long ago, a bridge 100 feet long across our main drainage canal was replaced by two 30-inch culverts each 60 feet long.

Some of the interesting features of this installation are shown in the accompanying illustrations.

The culverts were installed when water stood about five feet deep in the canal, completely covering the culverts.



Removing the canvas from the end of a 30-inch Armco corrugated culvert to permit it to sink into place in the drainage canal on the Holland Land Company project, where two culverts each 60 feet long replaced a wooden bridge.

As the ditching machine was nearby, we were able to save considerable "man-handling." Before the culverts were picked up by the ditcher, both ends were covered with canvas, making a cylinder capable of floating for some time. The culverts were laid in the water and stakes driven around them to keep them in position. As the canvas ends were pulled off, the culverts dropped into the exact location desired. The use of the canvas and stakes prevents "skidding"

out of position, and towing of the culverts around on the bottom after they have sunk. This is the same idea as is used in sinking caissons, and may prove useful to some of the readers of *The Highway Magazine*, who may have similar problems to solve.

The ditching machine backfilled over the culverts, so that we now have a solid road much wider than the old bridge. And thus one more maintenance account is practically closed.



Above is shown a drag line on the Holland Company's reclamation project picking up one of the two Armco culverts which replaced a wooden bridge that had failed under the heavy traffic during the beet season. Some idea of the extent of this traffic may be gained from the scene below showing a long line of trucks bringing beets to the hopper. At the right is shown one of the culverts in place floating by reason of the fact that the ends have been covered with canvas.

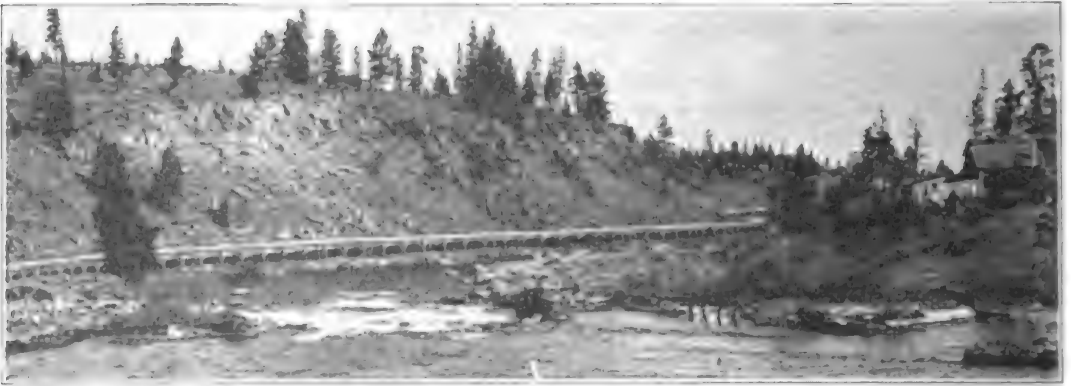
Vast Areas of Fertile Louisiana Land Await Drainage

APPROXIMATELY one-fourth of the entire state of Louisiana, more than ten million acres, may be classified as wet land or land that needs drainage to make it available for agricultural purposes. A large proportion of this is Mississippi River delta land which is exceptionally fertile and needs only adequate drainage to make it highly productive farm land.

During the period from 1907 to 1914 considerable progress was made, about twenty-five reclamation projects having been undertaken, some of them as large as 35,000 acres. Beginning with the World War there came a lull in drainage

activities owing to the cessation of colonization from the northern states, lack of funds, and provisions of drainage laws which hampered drainage developments.

In 1921, however, remedial state legislation was secured removing many of the legal obstacles. But what is most needed at the present time in order that Louisiana may successfully carry out reclamation projects on a large scale is the co-operation of the other states and organizations interested in the control of the Mississippi River and its tributaries for irrigation, flood control, navigation or water power projects.



Armco iron flume installed by the Coast Culvert & Flume Co. on the Deschutes County Municipal Improvement District of Tumalo, Oregon.

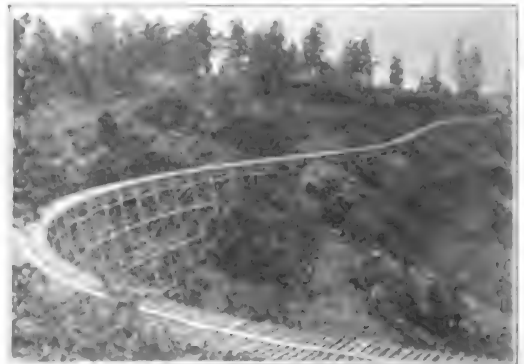
Detailed Survey of Reclamation Projects Being Made

Complete information on all government reclamation projects is expected to be available for the opening session of Congress this month. Field investigations of five new projects are also being carried on.

A SURVEY of Government reclamation projects for the purpose of classifying the soils, determining the financial condition of the water users, and fixing the irrigable areas against which charges may be assessed is being made by the Bureau of Reclamation in accordance with the recommendations of the special advisory committee's report.

In addition, field investigations of five new projects are also being carried on. They include the proposed Owyhee project in Oregon, the Vale project in Oregon, the Salt Lake Basin in Utah, the Spanish Springs in Nevada, and the Kittitas in Washington. A new plan was adopted by the Bureau of Reclamation with reference to the final recommendations on these new projects. It provides for the appointment of a committee made up of one member of the bureau, one recognized authority in farm management—preferably from the Department of Agriculture or the State Agricultural College—and one financial authority—preferably a banker in whom the State has confidence—to consider the facts and data collected. After considering them this committee will fix the costs of development, the probable value of products which can be grown, the

conditions under which settlement ought to be made in order to render the project



A view of the Armco iron flume near Bend, Oregon, one of the largest flumes of its kind in the United States.

feasible, or, if the conditions are unfavorable, will state that the project is not feasible.

The surveys will cover every phase, and it is hoped the information will be available for submission to Congress at the opening of its session this month. The plan of these surveys provide that:

A soil survey shall be made, and all irrigable lands classified according to their productive capacity, in not exceeding four classes. No land shall be ex-

cluded from such classification unless it clearly appears that it is incapable of successful irrigation.

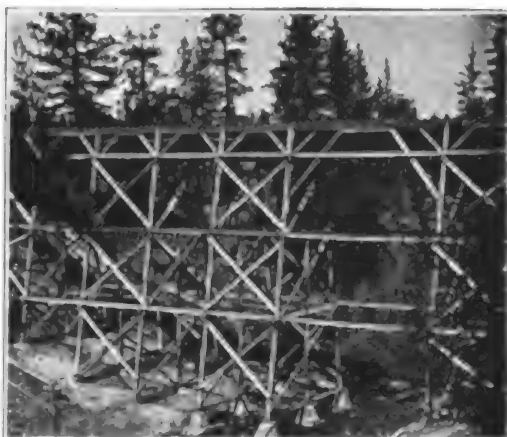
A census shall be taken on this subject upon blanks in form approved by the commissioner. Such census shall be for the purpose of ascertaining the assets and liabilities of each water user with the view of proposing a plan for refunding the indebtedness of individual water users, other than amounts owing to the United States as project charges, at lower interest rates and on more favorable terms otherwise.

The report shall show in each case what irrigable areas may be depended upon to return the charges assessable against them, and what must be excluded from further consideration. This shall be made as specific as feasible. If any additional areas may be irrigated from the project, a report shall be made thereon.

Careful consideration shall be given to present and prospective drainage needs, and the relation of this subject to the ability of the farmers to pay the cost.

The topography and soil of the irrigable area of each project shall be studied and a report made as to any area particularly difficult from any cause to prepare for irrigation, in order that it may be decided whether it would be feasible for the government to assist settlers in preparing such lands for use.

All excess irrigable land holdings shall be listed, with a showing in each



Trestle carrying a large Armco flume over a valley.

case as to whether the provisions of section 3 of the act of August 9, 1912 (37 Stat. 265), are being observed.

All irrigable vacant lands shall be reported with the reasons why the same are not being irrigated.

The report shall include a statement covering each project, showing what, if any, benefit to the government investment may be secured through the giving by the government of expert agricultural and economic advice to the farmers, including an outline of a practical plan of procedure.

Recommendations shall be made as to each project on the matter of improving general project conditions, as distinguished from individual conditions, through the establishment of creameries, sugar-beet factories, etc.

The subject of ultimate losses shall be exhaustively reported, and clear and convincing showings made thereon. The full assets and liabilities of each project shall be carefully set out in detail. The subject shall be treated both from a purely legal standpoint and from an equitable standpoint.

The feasibility of transferring to the water users in the near future the operation and maintenance of each project or division of a project shall be discussed in the report.

There shall be attached to the report on each project recommendations as to what action should be taken to bring the project to a prosperous and successful condition.



Armco ingot iron flume emptying into a masonry and earth extension.



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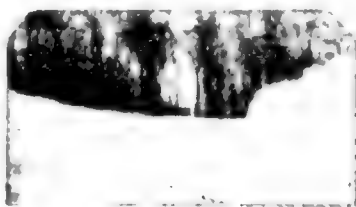
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The HIGHWAY MAGAZINE

An aerial photograph of a coastal town and harbor. The town is built on a steep, forested hillside that slopes down to a sandy beach. A winding road is visible on the hillside. The harbor is filled with numerous boats of various sizes, including sailboats and motorboats. A large, dark, rectangular building, possibly a warehouse or a shipyard, is situated on the waterfront. A long pier extends into the water from the town. The water is calm, and the sky is clear.

January
1925

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The Dixie Culvert & Metal Co.

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Indiana, Crawfordsville
The W. Q. O'Neill Co.

Iowa, Des Moines
Iowa Pure Iron Co.

Iowa, Independence
Independence Corr. Culvert Co.

Kansas, Topeka
The Road Supply & Metal Co.

Kentucky, Louisville
The Kentucky Culvert Mfg. Co.

Maryland, Baltimore (Munsey Bldg.)
The Maryland Culvert & Metal Co.

Massachusetts, Palmer
New England Metal Culvert Co.

Michigan, Bark River
Bark River Bridge & Culvert Co.

Michigan, Bay City
U. S. Bridge & Culvert Co.

Minnesota, Minneapolis
Lyle Culvert & Road Equip. Co.

Missouri, Moberly
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Montana, Missoula
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Nebraska, Wahoo
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New Jersey
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The American Rolling Mill Co.
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Oklahoma, Oklahoma City
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The HIGHWAY MAGAZINE

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The main crest of the Sierras as seen from the Tioga Road, a highway which bids fair to rival the famous mountain roads of Europe for scenic grandeur.



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Readers are urged to consult with Mr. Graham on technical questions arising in connection with highway and reclamation engineering.

Importance of Traffic Surveys to Highway Planning and Design

THE vital importance of having adequate and scientifically accurate information on which to base highway construction and maintenance programs as well as the design of the roads themselves is becoming more and more apparent as the vastness and significance of modern road building is being more fully realized. At the fall meeting of the American Society of Civil Engineers, held at Detroit, Michigan, on

October 23 and 24, considerable attention was given to this subject. At this meeting J. G. McKay, chief of the Division of Highway Economics of the U. S. Bureau of Public Roads, W. A. Van Duzer of the Pennsylvania Department of Highways, and H. G. McGee, Director of the Municipal Research Bureau of Akron, discussed transportation surveys as related to road planning and pavement design.

Mr. McKay outlined the results of the surveys in California and Connecticut, and Mr. Van Duzer that conducted in Pennsylvania. The California and Connecticut surveys showed traffic increases of nearly fifty per cent in two years.

Weighing of vehicle wheel loads as a supplement to counting has been facilitated by the development of two types of portable scale within the last two years, so that extensive data on wheel loads are now available. These show that the very large majority of freight wheel loads is moderate, but that a small number of excessive wheel loads is always present. The results of weighings on a given road is considered a direct basis for pavement design.

From the traffic data obtained, it is found that the fuel savings alone on the 360 miles of improved road in Connecticut, under present traffic, are sufficient to pay interest on the cost of the pavements and amortize the cost in 20 years.



The 2,000-foot multiple arch Gillespie Dam across the Gila River in Arizona which stores water for 100,000 acres. According to present indications (See pages 18 and 19) irrigation will be more important than ever during the next few years.



Measuring surface irregularities of bituminous test pavement at federal experiment station, Arlington, Va.

Research in Material and Design Cuts Costs of Highway Construction

An Exclusive Interview with THOMAS H. MacDONALD, Chief of the Bureau of Public Roads, U. S. Department of Agriculture

By GORMAN M. HENDRICKS

Washington Correspondent for The Highway Magazine

How various kinds of materials may be used with excellent results by mixing with small proportions of Portland cement, cinders, sand, or other material, depending upon the base to be modified, is herewith described by the man who is directing these experiments for the Federal government.

STABILIZATION of subgrades in highway construction has long been the goal of engineers. Recent research work in this field has resulted in the discovery of methods of preparing subgrades for road construction which in the next few years will save millions of dollars.

Formerly, when bad subgrade materials were encountered, it was the custom for the average constructor to obtain his materials with which to build up the base for his road from some distant point, thereby increasing the cost of the road to an appreciable degree.

This factor has been eliminated to a great extent by tests made recently in government research laboratories. Exhaustive tests have shown that an engineer on the ground can build up his own subgrade, regardless of conditions, for the most part from materials on hand.

Subgrades, as we all know, vary from solid rock to exceedingly plastic clay with all combinations of materials between these two extremes. The finely divided clays will absorb considerable water by capillarity and become incapable of supporting heavy loads. Moreover, they swell and shrink with changes in moisture content, producing heaving and cracking of road surfaces.

The idea of stabilized subgrades is recognized and carried out in a practical way in present methods of "stage" construction, in which a surfacing of sand clay or pit run gravel is used originally and until traffic warrants a better surfacing. In exceedingly bad soils, such as adobe of California, a layer of granular material is of value under any type of surfacing.

Another very important factor in highway construction that has been



A farm scene in New Hampshire. Modern highway developments have revolutionized farm life.

given a great deal of attention by government experts is that of road drainage. Moisture in the subgrade of the roads plays a most important part in its local carrying and service value.

Some soils, it has been shown, are incapable of supporting loads in the presence of moisture, therefore investigation of the best methods of drainage have been considered most important. One outstanding fact has been developed as



Device used at Arlington experiment station to determine effect of impact forces.

a result of such investigations, namely, that no system of drainage can remove the moisture held in the soil by capillarity, and that in some types of soils even capillary moisture makes the soil very soft and plastic. Drainage systems, however, are most effective in removing free water from the soils and for cutting off sources of free water so

that they will not reach the subgrade of the road.

As above stated, in the past many roads have been constructed with materials hauled from great distances, the theory being that local and more available materials were not suitable to the work at hand.

The cost of importing such materials can be eliminated from highway construction for the most part, as research has shown that many local materials may be successfully used in present day road building. A research recently completed at Arlington on a large number of aggregates developed the fact that softer aggregates, heretofore believed to be without value in construction, can be safely used. It was shown, for instance, that aggregates having a French coefficient of wear above six are perfectly suitable for present day concrete roads, and that many gravels previously thought unsuitable may be used.

It has also been shown how to take advantage of the use of blast furnace slag to obtain satisfactory results. Many sands now rejected by specifications will likewise be made available for road building; and the great cost of hauling expensive road material is thus being eliminated from the cost of road building as a result of modern highway research work.

Similarly, local investigations have shown the way to use the soft limestone and marl such as occur in Florida and North Carolina. Such materials make

excellent bases under more durable road surfacings. Tests have also shown that Florida limestone rock can be used advantageously on penetration macadam construction within a radius of economic haul.

The use of local materials for non-rigid bases has been largely developed in the Pacific States and other localities. In certain locations such as Massachusetts, North Carolina and Florida, the most common local material for road building is fine, clean, sand. In such localities a sand-asphalt surfacing which is satisfactory for local traffic, contains 93 per cent of sand, the local material available, requiring the importing of only 7 per cent, the asphalt in the mixture.

Ideas on reinforcement have changed rapidly and are still changing and furnish a fruitful field for further research. Some states use no reinforcement, and others use steel up to the amount of 100 pounds or more per 100 square feet, costing as much as \$10,000 per mile.

Research is needed to show the proper amount of steel to use in concrete roads for the greatest economy. Thus far such work has conclusively shown the efficiency of longitudinal steel placed at the edge of the pavement for strengthening the edge and serving in carrying loads across the joints.

Recent tests have developed a way to improve poor subgrade materials. As has been shown, admixtures of granular

materials such as sand, cinders or stone screenings materially cut down the capillary moisture content, greatly decrease the shrinkage and swelling and materially increase the bearing value of the subgrade under the worst conditions.

Where it has been impractical to employ the materials as mentioned, it has been found that the same results may be obtained with mixtures of hydrated lime and Portland cement in amounts to



Tests being made by the United States Bureau of Public Roads at the experiment station located at Arlington, Virginia. Reinforced paving is being laid on a circular track.

only five per cent of the weight of the soil. In this connection it has been shown that the five per cent mixture of Portland cement to a depth of one foot seems to have increased the supporting strength of concrete pavements by almost fifty per cent.



The 18-foot concrete road between Pascagoula and Moss Point, Mississippi. Federal aid was secured for its construction.

Eliminating the Small Wooden Bridge

The small wooden bridge, scene of many accidents in the past, is rapidly disappearing from our highways. In the following brief article is described a typical example of the more modern method of carrying a road over a creek or small stream.

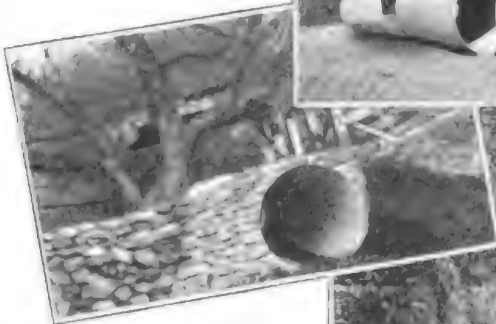
THE abnormal increase in traffic on our highways during the past two decades has compelled our highway builders to find a more suitable means for taking roads across small streams, creeks or other low places having a steady or intermittent flow of water, than the small wooden bridge. The latter has failed to stand up under the weight of traffic it must now bear.

its place. The accompanying group of pictures graphically portray this replacement, showing the three sections of culvert, the old condemned wooden bridge, the fill being made without interruption of traffic, and the completed installation. It is wide, substantial, permanent; provides adequate drainage, and eliminates continual repair and maintenance costs.

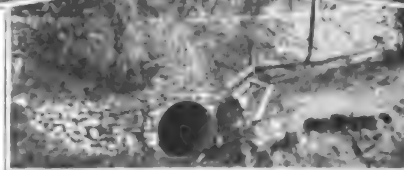
To the right is shown the three sections of Armco corrugated culvert which replaced a wooden bridge in Watts Valley, Fresno County, California.



Directly below appears the old Watts Valley wooden bridge which was condemned, and replaced with a fill and Armco corrugated culvert.



Above is shown the culvert installed and the fill partly completed with the bridge still in place, preventing any interruption of traffic.



To the left is the completed installation, a substantial and permanent structure which will eliminate further maintenance costs.

A very practical and satisfactory solution has been found in the use of metal culverts of varying sizes either singly or in batteries.

This method was followed by Supervisor Robert Lohead, in replacing a wooden bridge recently in Watts Valley, Fresno County, California. As the old bridge was no longer considered safe, it was condemned to be replaced with a more adequate structure. A corrugated culvert made of Armco ingot iron 60 inches in diameter was chosen to take

The economy of this form of installation results not only from the lower cost of material, long life, and absence of maintenance and repair costs, but also from the lower installation cost. No expensive equipment is required, and highly skilled labor is likewise unnecessary. And in addition the cost of providing and maintenance detours while the work of installation is in progress is eliminated. The work of installing the culvert and making the fill can go on while the traffic is still using the bridge that is being replaced.



A scene along the Northwestern Turnpike in Mineral County, West Virginia.

How West Virginia Is Solving Its Highway Problem

By GEORGE H. HILL

Office Engineer, State Road Commission of West Virginia

Because of the extremely rugged nature of its territory, West Virginia's road building problem is a difficult one, both from the engineering and financial standpoints. How it is being solved is briefly described herewith.

GRADING is a more difficult problem than paving for the road builders of West Virginia. Over the entire state the topography is rough, and in most places mountainous. This means more excavation, more fills, more rock blasting, more retaining walls, more small bridges, more culverts, and more guard rails than in a level or rolling country.

Selection of paving types is governed largely by location. Throughout the greater part of the state, suitable rock for road base is abundant. This has led to the extensive use of the bituminous macadam type, usually applied by the penetration method. For projects near the Ohio River, a plentiful supply of good gravel is convenient and has been utilized to a considerable extent. In the eastern Panhandle, and in some of the other countries along the eastern border, there is found a high grade shale, with which numerous roads have been satisfactorily surfaced at low cost. Besides the bituminous macadam, concrete has been extensively used where one of the higher types of paving is advisable.

West Virginia has a great many nar-

row valleys between mountains which contain vast quantities of coal. To reach this coal, railroads were built. When the road-building era dawned, and motor vehicles began to demand highways in all parts of the state, it was discovered that in many cases the railroads had used the only available routes through the valleys.

Thereupon, it became necessary to



A concrete retaining wall anchored to underlying rock on the Elizabeth Pike, Wood County, West Virginia.



A scene on one of West Virginia's modern highways, the Parkersburg-Stanton Turnpike between Weston and Camden in Lewis County. This is a curbless brick road.

steam-shovel and blast out grades along the hillsides. This problem was attacked energetically by both county and state road engineers, and the result is highways of great scenic beauty as well as utility.

Among the problems of mountain-side road construction encountered by West Virginia engineers, is that of slides. Since the days when the hills and mountains were pushed up from level plains, the sides of some of them have been slowly sliding back into the valleys. To the Indian, and even to the early settler, these sliding hills were not a matter of great concern, but to the builders of hard-surfaced roads they are a serious obstacle. Hard surfaces are cracked and twisted by even a slight slip in the earth supporting them, and any considerable slip means destruction.

The solution of this problem was undertaken systematically. Borings were made which showed that the surface consisted of from five to ten feet of clay, below which came a layer of shale or soapstone, and beneath this was solid rock. Melting snows and spring rains saturated the clay and seeped through to the soapstone, forming a greasy toboggan down which the clay moved, carrying everything with it.

It was at first believed that by breaking up the slippery layer between the clay and the bedrock, the water would go through to the rock, and the toboggan would not be found. Experience showed that the blasting merely pulverized the intermediate layer, so that the water mixed with it more readily than before, and the slides continued.

Finally it was decided to try light "anchored walls." In building these walls, holes are drilled with an ordinary well drill, through the surface and five feet into the bedrock. In these holes are placed well casings, extending up to the surface. These casings are filled with concrete. Then a light concrete wall is built on the bedrock, around the casing. Next, similar holes are drilled on the upper sides of the roadway, and casing set in the same manner. Then the casing on the lower side is fastened to that on the upper side with iron bars encased in concrete. This arrangement has proved effective wherever used. Sometimes the concrete-filled posts alone stop the slide, and the wall is unnecessary.

West Virginia's state road system was created by a constitutional amendment adopted by the people in 1920, and by legislation based on this amendment passed by the legislature of 1921. It is provided that the state road system shall connect at least the county seats of all the counties. The legislature is permitted to authorize the sale of road bonds not to exceed \$50,000,000 outstanding at any one time. Of these bonds, \$30,000,000 have been sold and the proceeds expended or placed under contract. Both designation and construction of the roads constituting the state system were placed in the hands of a State Road Commission of three members, appointed by the governor.

The total mileage designated on the state road system is 3,582. Of this the total now improved or under construction is 2030.71 miles.

What the Yellowstone Trail Association Has Done to Promote Highway Construction

By R. B. ANDERSON,

Director of Bureaus, The Yellowstone Trail Association, Inc.

Planning routes for long distance motor travel, crystallizing sentiment along these routes into demand for highway improvement, and helping to make this demand effective through organized effort, are the essential contributions of the Yellowstone Trail Association.

THOUGH much enthusiasm in favor of good roads had been developed by the time The Yellowstone Trail Association was organized in October 1912, the lack of definitely formulated programs and organized promotion was resulting in confusion and considerable waste of the rather liberal funds that had already been provided for highway improvement. The automobile was just coming into general use as a medium of transportation for comparatively long distances, and road officials were being urged to pave or otherwise improve a vast number of roads.

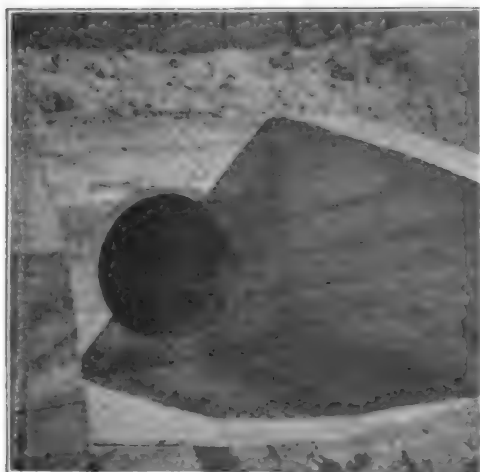
Since the most logical thing to do was to pave or improve those roads first which carried the most traffic, the Yellowstone Trail Association was organized to plan definite routes connecting up roads already in use, encouraging people to use these routes, and crystal-

lizing and organizing the demand for improving them to the extent that the money would be provided and the work actually done.

The association, which is incorporated under the laws of South Dakota, is or-



A stretch of good road on the Yellowstone Trail between Hudson and Eau Claire, Wisconsin.



A 24-inch Armco culvert under the Point Douglas Road section of the Yellowstone Trail.

ganized like a chamber of commerce, the membership being composed of individuals and firms in the communities along the route of the Trail. It had its inception at a conference of business men in the little town of Ipswich, South Dakota, in the spring of 1912. This meeting had been called for the purpose of considering the improvement of the road between Ipswich and Aberdeen, a distance of 26 miles. Favorable action was taken, and the road was improved. In a short time this stretch of road had grown into a highway extending 100 miles, from Aberdeen to Mobridge on the Missouri River.

Shortly after this at a meeting in Lemmon, South Dakota, it was decided to promote a great highway extending



Installing an Armco corrugated culvert under a 24-foot fill on the Yellowstone Trail.

from the falls of St. Anthony in the Mississippi River at the Twin Cities to the Yellowstone Park, a distance of about 1,100 miles. This proposed highway was called the Twin Cities—Aberdeen and the Yellowstone Park Trail. This meeting was the real beginning of the Yellowstone Trail.

In 1914 it was decided to extend the highway from the Twin Cities east to Chicago and west to Seattle, and this new and enlarged highway was called "The Yellowstone Trail," a name which it has had ever since. Two years later the trail was again extended, this time from Chicago to the Atlantic coast, and it is now a "good road from Plymouth Rock to Pudget Sound," a distance of a little over 3,700 miles.

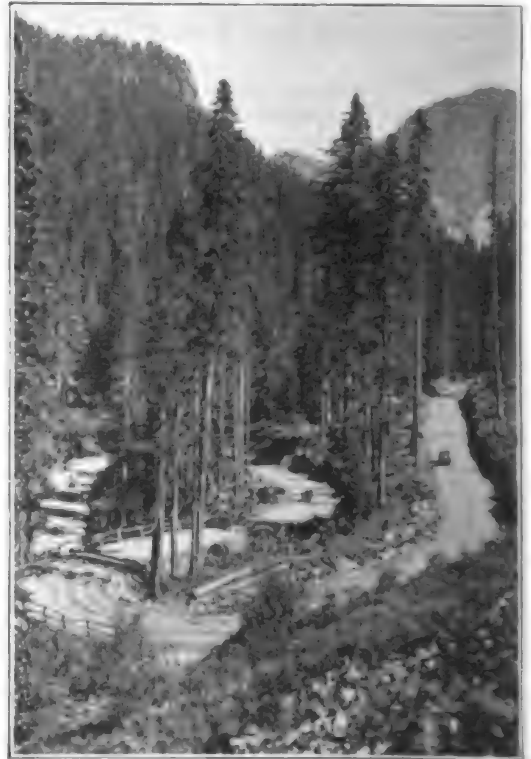
The association plans to erect permanent markers along the entire route of the trail. The marker used is of metal 11 by 14 inches, with a 10-inch black circle on a yellow background with the lettering, "The Yellowstone Trail" in black, and in the center a black arrow. The arrow always points to the Yellowstone National Park. Some of these markers have already been erected, and their number will be increased as traffic demands, and the work can be done.

The information bureau work is the largest single service rendered the public by the association. Thirteen touring information bureaus have been established, located at: Walla Walla and Spokane, Washington; Missoula, Butte, Billings and Miles City, Montana; Aber-

deen, South Dakota; Minneapolis and St. Paul, Minnesota; Milwaukee, Wisconsin; Chicago, Illinois; Fort Wayne, Indiana; and Cleveland, Ohio. Each bureau has a supply of maps of each state in the Union and of the most important highways, as well as booklets on local interests and summer resorts.

During the season of 1922 the bureaus handled approximately 58,000 automobile touring parties traveling 1,000 miles or more on the Trail. These automobiles carried a little over 186,000 people. In 1923 over 250,000 tourists were handled.

One feature of The Yellowstone Trail Association's service is the road condition map it issues. This is a large wall map showing the route of the Trail across the United States. With it is furnished each week a report of the condition of the highway section by section. This service is supplied from May 1 to September 15 of each year.



An excellent view of the double hairpin turn on the Yellowstone Trail at Snoqualmie Pass in the State of Washington.



Dumping and finishing concrete during the reconstruction of the Old National Road between Frederick and Baltimore, Maryland.

Reconstructing the Old National Road to Meet Modern Traffic Demands

An Interview with W. F. CHILDS, JR., District Engineer,
Maryland State Roads Commission

By J. M. ALVEY

Placing waterbound macadam, surfaced with refined tar and chips, over the original foundation and adding width by means of concrete shoulders has enabled a famous old highway to carry the heavy traffic of today.

IN 1805 the Baltimore and Frederick Turnpike Company was chartered by the General Assembly of Maryland. That was the first step in the laying out of the "Old National Road," which runs from Baltimore, Maryland, to Wheeling, West Virginia, a distance of 268 miles.

In 1806 the Congress of the United States passed an act "to regulate the laying out and making of a road from Cumberland in the State of Maryland, to the State of Ohio."

The Treasury Department advertised for bids in 1810 for the building of this road. The roadway was to be thirty feet wide with the right-of-way cleared of trees and bushes to a width of sixty feet. The roadbed, to a width of twenty feet, was to be covered with twelve inches of stone broken small enough to pass through a three-inch ring.

Such were the beginnings of the hundred-year-old highway which the State Roads Commission of Maryland reconstructed to meet the demands of modern traffic.

"Over the old stone base the turnpike companies and the United States Government laid in the beginning of the nineteenth century," said Mr. W. F. Childs, Jr., District Engineer of the State Road Commission, with headquarters in Frederick, "the State Roads Commission put down a highway of waterbound macadam. Little change was made in grade or alignment and the road today, in those respects, is much the same as it was when built by the U. S. Army engineers.

"Upon completion of the macadam, the road was given a surface treatment of refined tar and chips; and this process was repeated every year until a good water-tight surface was obtained."

Regarding maintenance, Mr. Childs stated that this is a matter given careful attention on the Old National Road. Sections of the road are treated every second or third year with oil and chips, the frequency of the treatment depending on such matters as traffic, the quality of the materials last used, the weather, etc. State maintenance forces are busy

with this work during the summer months.

For ordinary maintenance work, such as the filling of small holes, the cutting of weeds, and the keeping open of gutters and culverts, the road is divided into sections of about five miles and placed in care of a patrolman. These men, who are well trained, live in the vicinity of their patrol sections.

Included in the maintenance system



Pouring the concrete hauled fourteen miles from a central mixing plant for the widening of the Old National Road.

on the Old National are such items as the removal of snow, the whitewashing of the telephone poles and culverts, the widening and banking of curves, and the surface marking of the road to indicate the lanes that traffic should take on curves and at the top of grades.

For the convenience and guidance of motorists through the state, the Roads Commission has had erected at cross roads and other points along the National Road, signs giving direction and distance to all important points. At the entrance to all large towns, 10-foot square maps have been put up giving the main and secondary streets through such places, and showing what streets to follow to gain other highways.

"Surface drainage," Mr. Childs explained, "is taken care of by ditches that parallel the roadbed, and by culverts. Subsurface drainage is disposed of by means of tile under the roadway wherever necessary. In all instances the natural drainage of the surrounding land is taken into consideration and is used to advantage."

By means of an "Accident Map," the purpose of which was explained by the writer in the August number of *The*

Highway Magazine, the State Roads Commission was able to determine that accidents were alarmingly frequent on the Old National Road, especially between Frederick and Baltimore, due to narrow width and excessive shoulder. Accordingly a three-foot concrete shoulder was constructed on each side of the driveway from Frederick to Ellicott City near Baltimore, a distance of 34 miles, at a cost of approximately \$400,000.

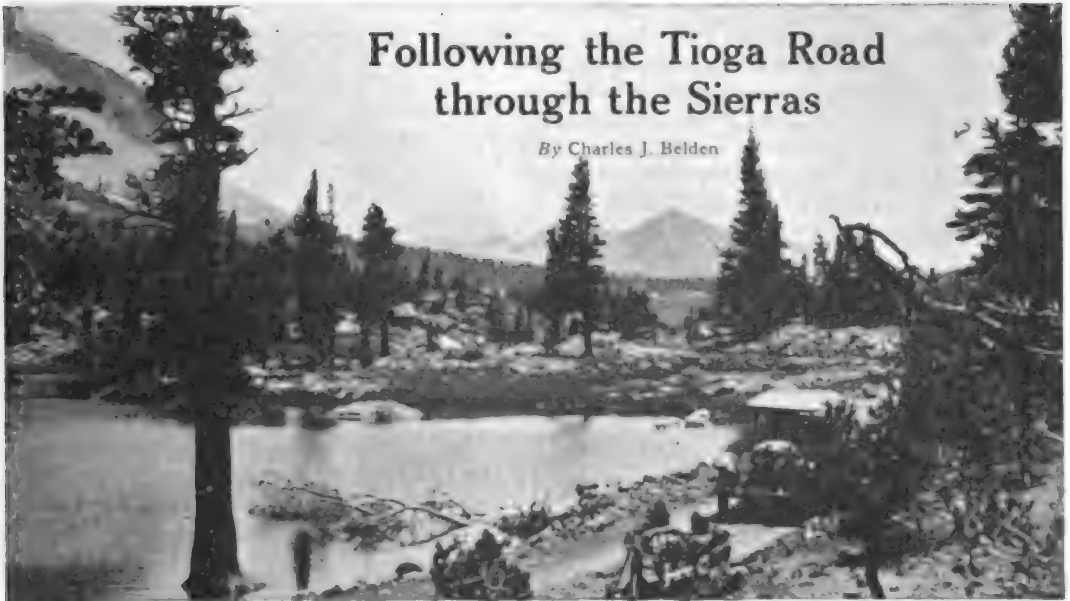
All of this concrete shoulder construction lies in Mr. Child's territory, who said of it:

"The construction of these shoulders increased the width of the road from 14 to 20 and 21 feet. Concrete, made of one part portland cement, two parts washed sand and four parts washed gravel, was poured between 8 inch metal forms on the outside and wooden forms on the side next the macadam. A unique feature of this work was the fact that the concrete was mixed at a central plant on a nearby railroad and hauled to the scene of construction in state road trucks. In some cases the mixed concrete was taken as far as seventeen miles before being dumped into place. The average haul was around eleven miles. Upon completion of the shoulders the State's maintenance forces and equipment built the macadam against them."

It is the desire of the State Roads Commission to continue this work and thus make of the Old National Road one of the finest, as it is now one of the most historic, highways in the country.



View showing forms still in place against freshly laid concrete shoulder used for widening a section of the Old National Road.



Following the Tioga Road through the Sierras

By Charles J. Belden

An excellent view of the wind swept shore of Tioga Lake near summit of the pass.

TO the motorist with pioneering instinct who delights in exploring the unbeaten paths, the great chain of snowy Sierras that border our western coast offers untold possibilities. Crossing the Sierra Nevada Mountains just to the north of Yosemite Valley is a road that some day bids fair to attain a world wide reputation equal to that of the older highways of Europe. The Tioga Road, as it is called, penetrates the very cream of the scenic grandeur of the whole length of the Sierras, and offers to the wayfarer an array of rugged, granite peaks that would satisfy the most "blase" alpinist.

The Tioga Road was constructed in 1882 by the Great Sierra Mining Company for the purpose of transporting supplies to their mine in the very summit of the Sierras. The name "Tioga" was taken from Tioga county in New York State, which was the home of a man named Burdick who located the mine. The road was skilfully laid out, and the construction was of unusually permanent character for mountain roads in California. Retaining walls were located wherever there was the least necessity for them, and the surfacing of the road was exceedingly good. Chinese labor was used to a large extent, and

the entire cost was very close to \$61,000, or approximately a thousand dollars per mile.

The road barely reached completion, when the mine proved to be a losing venture and the entire workings were left to the mercy of the elements. For many years after the abandonment of the Tioga Mine, dishes could still be found on the tables, and clothes hang-

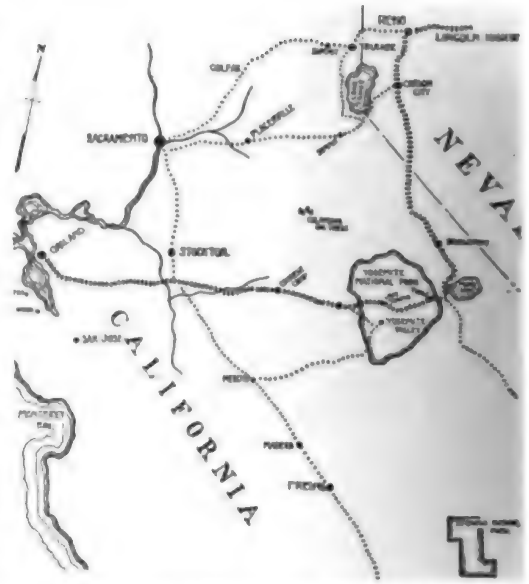


A section of the Tioga Road in the Yosemite Valley lined with magnificent pine and fir.

ing on the walls just as they had been left by the miners when one day they all stopped work and walked out of this desolate region of wind swept peaks. Almost a million dollars was spent in this undertaking, which only added another chapter to the history of the many financial tragedies of western mining.

The importance of the Tioga Road had been recognized for some time, not only as a means of establishing a new route across the mountains and opening up the northern part of the Yosemite region, but as a connecting link of unsurpassed scenic qualities for transcontinental travel. It was not until 1915, however, that the road was finally acquired by a group of patriotic citizens headed by Stephen T. Mather of Chicago, and deeded over to the Government. In July of the same year, through the co-operation of the Interior Department and the Department of Engineering of the State of California, this remarkable highway, which had remained in a state of neglect for a great many years, was opened to motor car travel.

The Tioga Road as originally built, had its initial point at Sequoia or Crocker's Station. Two miles beyond Sequoia, a covered bridge spans the South Fork of the Tuolumne River, and leaving the Yosemite route here, a gradual ascent leads for twenty miles through a luxuriant forest of pine, spruce and fir, interspersed with groups of imposing se-



A map showing the principal cities and points of interest in Nevada and California reached by the Tioga Road.

quoia. The grade is a rather remarkable one, for although it rises from the Tuolumne River at 4,350 feet to the Yosemite Creek divide at 8,500 feet, most of it can be travelled in high gear at an easy gait.

As the road emerges above Yosemite Creek, very comprehensive views of the whole upper Sierra region are framed in the drooping branches of graceful sugar pines with their great cylindrical cones swinging at the very tips.



A magnificent view of the peaks of the Sierras from Tioga Pass. At this point the highway reaches an elevation of 9,941 feet.



A view of the Tioga Road in the Sierras showing the extremely rugged nature of the country through which it passes, and indicating the engineering difficulties that had to be overcome.

A descent of four miles brings the road to Yosemite Creek whose banks offer numerous choice camping spots. Especially will the disciple of Izaak Walton be tempted to linger here.

The next nine miles to the summit of Snow Creek divide contain a few sharp pitches that will reach twenty per cent for short spaces, but the road bed is hard and little or no difficulty is encountered. Years of neglect almost entirely effaced the original good surface, and it has taken a long time to make a smooth top again. Two miles below Snow Creek divide lies Lake Tenaya, a wonderful body of liquid blue, set in a massive bowl of granite. Sweeping up from the surface of the lake, great masses of rock stretch to the very summits of the peaks, thousands of feet above. The road hurries down to the shores and skirts the lake along an exceedingly well built sea wall blasted from the solid rock. From the head of Lake Tenaya, the route ascends eastward through a narrow gorge, whose walls rise sheer on either side far into the blue of the sky. Many a diminutive waterfall is supplied from melting snow-drifts high up on the granite peaks, and each fall contributes its share to the rushing torrent beside the road.

Nine miles beyond Tanaya, the flow-

ery expanse of Tuolumne Meadows is suddenly spread at the traveller's feet. These meadows, encircled by the majestic peaks of Mounts Lyell, Gibbs, Dana and Cathedral Peak, are far famed as the most beautiful open land in the whole length of the Sierras. Through the center of the meadows the Tuolumne River meanders in a leisurely fashion, as though it were gathering strength for its wild plunge through the Tuolumne Canyon into Hetch Hetchy Valley to the West.

After traversing the Meadows, a gradual ascent brings the road to the summit of Tioga Pass, at an elevation of 9,941 feet above sea level; the highest road pass in the Sierras. A splendid array of rugged wind swept peaks is presented on all sides, while on the floor of the Pass a few struggling pines are fighting against the elements for their existence. After passing Tioga Lake, the road follows the winding course of Leevining Creek as it threads its way through masses of curious stone formations. The huge rocks begin to close around in their desolate grandeur, when, without warning the road plunges into the awe inspiring depths of Leevining Canyon. Thousands of feet below lays the vast expanse of the desert to which the whole range falls in sharp, hurrying abruptness, the granite walls scarred into a thousand sculptures of buttresses and spires hewn by the mighty forces of nature. A remarkable piece of engineering carries a smooth, well graded highway, hundreds of feet above the foaming torrent, for nine miles down the almost vertical sides of this gorge, affording views of terrifying impressiveness.

For over two miles this piece of road was cut from solid granite, and it is notable for the substantial manner of its construction. It was built by the State of California at a cost of fifty thousand dollars, having been commenced in 1901 and finally completed in 1911.

From the mouth of Leevining Creek the road drops down to the shores of Mono Lake, the Dead Sea of the West. At this point is encountered the old El Camino Sierra, the road that parallels the eastern flank of the mountains, hugging close under their massive wall from Owens Lake to Reno, Nevada, where it joins the Lincoln Highway.



An Economical Method of Maintaining Water Levels

How lowlands may be kept free from surface water and, conversely, how water may be kept up to certain levels in ponds for lumber mills, duck preserves, salt works, parks, etc., through the use of corrugated pipe fitted with automatic gates at both ends, and placed under the levees or dikes, is outlined in the following article.

IN the lowlands of the Sacramento and San Joaquin Valleys of California are great areas of fertile land protected by dikes and levees. To permit the raising of crops, it is necessary to rid them of surface water and also to protect them against back-flow. Pumping the water over the levee from a sump is expensive, because of the cost of the pumps in the first place, and the provision of power as well as a certain measure of supervision. A corrugated pipe through the levee with an automatic valve on the outer end solves the problem. Water flows freely from the

land to the river whenever the latter is at low or medium stage, but is effectually prevented from reflooding the drained areas when the river rises to higher levels.

During the past year or two an application of the exact reverse of this principle has been found decidedly useful in connection with duck ponds, log ponds and seashore lakes. A pipe installed with an automatic gate on the outer end results in ridding land of surface water and maintaining it in that condition in the face of later rises of the water in the drainage way; but a reversed installation



A light frame construction with wooden lever for raising the Calco drainage gate used in draining low marshy lands, as described in the above article.



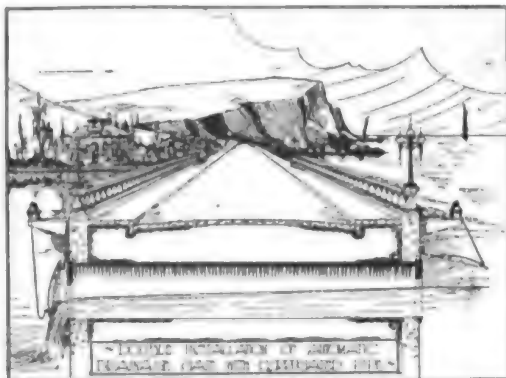
Armco sheet iron used for wasteway on Bishop Creek Ditch Company's project on the Owens River in California.

(the gate on the inlet end of the pipe) works in the opposite way, that is, it tends to maintain a pond inside the dike at a level corresponding with the high level of the tide or river. Whenever the water rises outside the dike it flows freely into the pond; but as soon as its level falls below that of the pond the gate closes and the water is retained. In this way ponds, lakes and storage reservoirs are maintained throughout the year at the highest levels reached by neighboring bodies of water, save for such losses as occur through evaporation and seepage, and this without any expenditure for power or supervision. At lumber mills, on duck preserves, salt works and at riverside and seaside parks this arrangement is of great practical importance.

Now comes a still further development of the same idea. There are many situations where it is desirable to maintain ponds at certain seasons and at other times to drain the land so that it may be used for other purposes. Sometimes the same area can be made to serve as duck ponds in the fall and winter months and as cattle pasture in the spring and summer. This can readily be accomplished by having automatic gates at *both* ends of the corrugated pipes that extend through the dikes. Those on the inner or reservoir ends will serve to establish and maintain the ponds and those on the outer ends to drain them and prevent re-flooding. It is necessary, however, to raise the gates that are not in use and support them in some way so that they

will remain open. A simple device for this purpose consists of an eyebolt near the lower edge of the valve to which is fastened a chain which is worked by a lever above. A practical wooden lever and frame is shown in the accompanying photograph. Where a neat appearance is especially desirable (as where the gates are on park lands or other improved property) a concrete control works like that shown in the drawing may be employed.

Such an installation is practically an automatic pump that works without

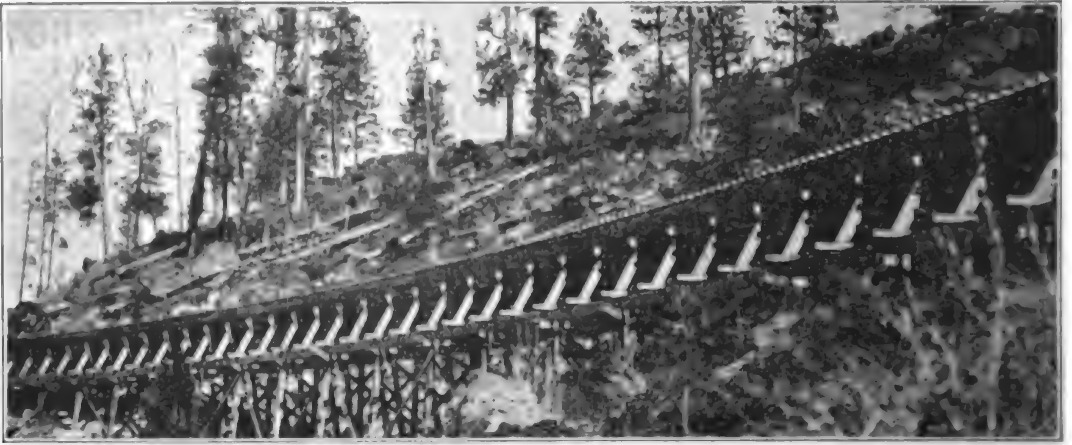


Drawing showing double installation of Calco automatic drainage gates with Armco corrugated culvert, as described in the accompanying article.

power or attention. It is easily put in place at very moderate cost, and its construction is so simple that repairs or adjustments are seldom required.



Headgates attached to Armco culverts used by the Bishop Creek Ditch Company's intake on the Owens River.



An Armco ingot iron flume installed by the Coast Culvert & Flume Company on the Deschutes County Municipal Improvement District of Tumalo, Oregon.

Three Year Dry Period Probable

New developments in weather forecasting in which the study of solar variations and ocean temperatures play important part indicate low temperatures and consequently reduced rainfall during the next three years.

HERETOFORE weather forecasts that have been made with any degree of accuracy have been based on atmospheric studies, limiting them to a matter of hours or a few days at the most. But as the results of scientific investigations made by a number of prominent meteorologists and weather bureaus in this and other countries, it now seems highly probable that we shall be able to tell what the weather will be for several years in advance.

That ocean currents have had an important bearing on the climate of neigh-

boring lands has long been known, and in recent years considerable time has been devoted to the study of ocean temperatures by British, Danish, Dutch and Norwegian weather bureaus. Even more significant has been the work of Herbert Janvrin Browne of Washington, D. C., whose weather forecasts for the past year based on these studies have been too accurate to be considered merely fortunate guesses.

Variations in the sun's heat, as measured by Dr. C. G. Abbot of the Smithsonian Astrophysical Observatory, form

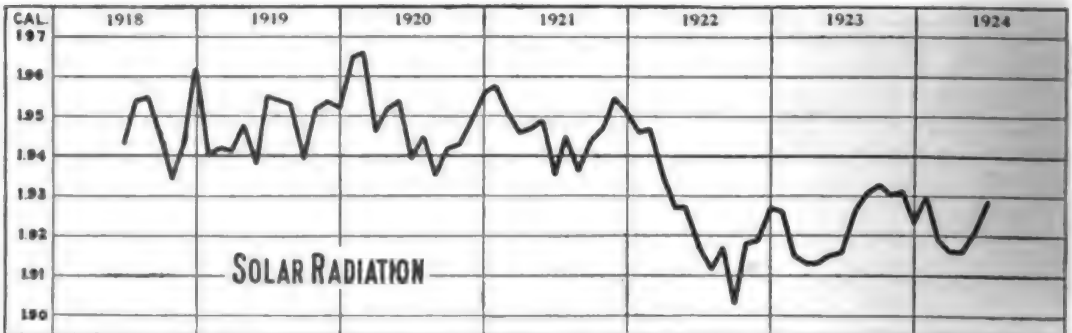


Chart showing variations in solar radiation as measured by Dr. C. G. Abbot of the Smithsonian Astrophysical Observatory.

the basis of these studies, which also cover the time required for the difference in solar radiation to produce its effect on ocean temperatures and ocean currents. Calculating the influence of these forces on the climate of inland regions through the study of their effects on off-sea moisture bearing winds also enters into these studies.

It would appear from the studies made so far that each of the three great oceans

observations and studies made up to the present time.

From the accompanying chart it is evident that there was a decline in solar heat from 1.955 calories to 1.903 calories from November, 1921 to September, 1922, the lowest since these observations began in 1905. With the exception of a brief increase during the summer of 1923, solar heat has remained at a relatively low level, averaging for the first half of 1924 about 1.922 calories. As the oceans have not yet had time to respond fully to this drop, their temperatures during 1925 and 1926 are likely to be still lower than they are now. A still further decline in temperature is forecast for the Atlantic and Pacific oceans during 1926 and 1927.

The opinion of prominent meteorologists and forecasters is that these low ocean temperatures will cause abnormal weather with generally low temperatures. This means lower evaporation and therefore less rain and snowfall.

In view of these deductions, which are being given credence by the recognized authorities, it would appear advisable for all interested in agricultural lands requiring full or partial irrigation to be prepared for a period of light rainfall lasting several years, as considerable additional irrigation may be necessary in order to produce normal crops. The economic value of accurate forecasting of weather several years in advance is too great to be even approximated.



Armco ingot iron flume installed by the Coast Culvert & Flume Company on the Cascade Irrigation District at Ellensburg, Washington.

has its own period of time for responding to the changes in solar radiation, the Indian Ocean being first, the Atlantic second, and the Pacific, particularly the northeastern quarter of it, the last to become adjusted. Approximately three years is required for a change in solar heat to become completely distributed in the North Atlantic, according to the



A model fruit farm in the famous Hood River Valley of Oregon, showing a fine strawberry field in the foreground, peach orchard to the left and apple orchard on the hillside in the background. Were it not for irrigation this would be dry and practically worthless.



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5 Important Causes of Culvert Failures

Field investigation of some 18,000 culverts indicates the five principal types of culvert failures are:

1 *Cracking:*

Due to load of traffic and fill on brittle material. Can be avoided by using elastic materials.

2 *Disjointing:*

Caused by lateral soil movements and poor foundations. Can be minimized by using culverts having a positive bond between sections.

3 *Breaking:*

Due to impact of traffic on culverts under shallow fill. Can be avoided by using flexible type culverts.

4 *Undermining:*

Caused by erosion of foundations. Can be minimized by using types of culverts which adapt themselves to unusual conditions.

5 *Disintegration:*

—Of Porous Materials

Caused by freezing and thawing. Can be avoided by using a non-porous material.

—Of Metallic Materials

Caused by electrolytic action set up in the metal. Can be minimized by using culverts made of Armco Ingot Iron which contain a minimum of impurities.



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